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ECONOMIC ANALYSIS OF EFFLUENT GUIDELINES

BEET SUGAR INDUSTRY

Development Planning and
Research Associates, Incorporated

Prepared for
Environmental Protection Agency

August 1975

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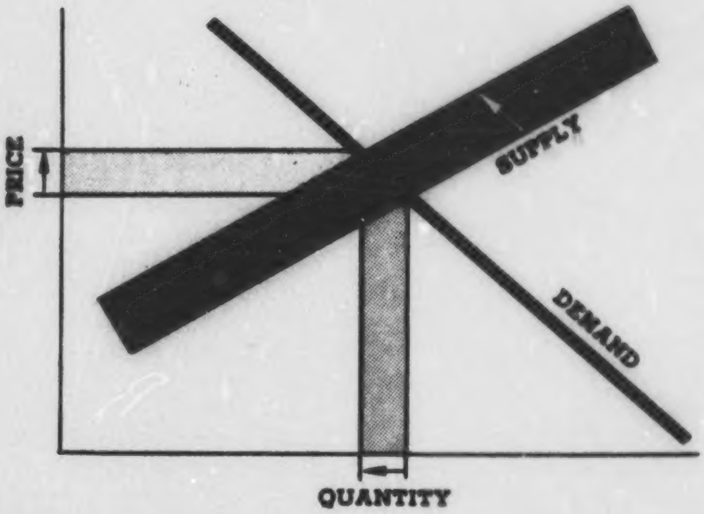

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The beet sugar industry, SIC 2063, is composed of 52 operating plants owned by 10 firms. Beet sugar plants are old with 38 plants built prior to 1933. Nineteen plants have 55 percent of industry capacity. Estimated after-tax return on sales range from zero up to four percent depending on plant size and campaign length. Prices are indirectly controlled under the Sugar Act by adjustments in domestic production acreage and impact quotas.

Imposition of effluent limitations are not expected to raise prices because large portion of the capacity is at a near zero discharge level. Ultimate price responses, however, are believed to depend on the Secretary of Agriculture's action on quota adjustments. Potential closures due to imposition of zero discharge standards are estimated to be 7 to 17 plants (8 to 26 percent of beet sugar production). A discharge of .5 pounds

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BOD in 1977 for plants without land available for control facilities of zero for plants with available land is estimated to cause 4 to 10 potential plant closures.

A standard of .5 lbs. BOD in 1977 and .3 lbs. BOD for plants with 2,300 daily tons of capacity or less and/or a daily soil filtration rate of 1/16-inch or less and zero discharge for all other plants in 1983 is estimated to cause 4 to 7 closures.

Employment impacts of potential closures appear to be small. Potential plant closures are likely to be felt more by communities through the loss of a high value cash crop by growers. Michigan and Colorado are believed to be areas most seriously impacted.

The impact analysis is based upon a number of assumptions and cost estimates which are identified.

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PREFACE

The attached document is a contractor's study prepared with the supervision and review of the Office of Planning and Evaluation of the U.S. Environmental Protection Agency (EPA). Its purpose is to provide a basis for evaluating the potential economic impact of effluent limitations guidelines and standards of performance established by EPA pursuant to sections 304(b) and 306 of the Federal Water Pollution Control Act.

The study supplements an EPA technical "Development Document" issued in conjunction with the promulgation of guidelines and standards for point sources within this industry category. The Development Document surveys existing and potential waste treatment and control methods and technologies within this category and presents the investment and operating costs associated with various control technologies. This study supplements that analysis by estimating the broader economic effects (including product price increases, containued viability of affected plants, employment, industry growth and foreign trade) of the required application of certain of these control technologies.

This study has been submitted in fulfillment of Contract No. 68-01-1553, Task No. 1 by Development Planning and Research Associates, Inc. Work was completed as of August 15, 1975. The study is based primarily upon an earlier study, also prepared by Development Planning and Research Associates, Inc. entitled "Economic Analysis of Proposed Effluent Guidelines for the Beet Sugar Industry." The earlier report was circulated in conjunction with the publication in the Federal Register of a notice of proposed rulemaking under sections 304(b) and 306 for the subject point source category. The analysis contained in the original study has been updated based upon information received during the period of time between publication of the notice of proposed rulemaking and the promulgation of the final regulation. Because of the constraints of time, the control and treatment costs analyzed in this study may not, in all instances, be identical to those associated with the requirements of the promulgated regulation. However, those differences, when they exist are minor insofar as the final conclusions of the study are concerned.

This report represents the conclusions of the contractor. It has been reviewed by the Office of Planning and Evaluation and approved for publication. Approval does not signify that the contents necessarily reflect the views of the Environmental Protection Agency. The study has been considered, together with the Development Document, information received in the form of public comments on the proposed regulation, and other materials in the establishment of final effluent limitations guidelines and standards of performance.

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EXECUTIVE SUMMARY

INTRODUCTION

This report analyzes the economic impacts of water pollution controls on the beet sugar processing industry. It is one of a series of studies prepared under the supervision and review of the Office of Planning and Evaluation, U.S. Environmental Protection Agency, as required by the Federal Water Pollution Control Act Amendments of 1972.

Under the provisions of Section 304 and 306 of the Federal Water Pollution Control Act, EPA has established effluent guidelines which apply to the processing of beet sugar. The purpose of this study is to evaluate the potential economic impacts of those guidelines prior to their implementation.

The report which follows describes and analyzes the beet sugar industry in terms of :

- Number and types of firms and plants
- Size and location of plants
- Financial profiles of representative model plants
- Pricing practices and supply/demand relationships

Then, pollution control costs are superimposed on the model plant financial profiles to analyze microeconomic effects, such as unit cost increments, price increases and potential closures. The microanalysis is followed by a macroanalysis to evaluate effects on employment, communities and foreign trade.

Data for the study were taken from published government reports, industry studies and confidential information from operating companies.

I. INDUSTRY STRUCTURE

Beet sugar processing (SIC 2063) has ten firms operating 52 plants as of 1973. The firms range in size from single-plant firms with annual sales of $750,000 to $2 million up to one 17-plant firm with sales of $190 million.

All of the firms are engaged primarily in beet sugar processing, with little diversification and integration. There is a movement toward purchase of some plants by beet growers, with cooperative organization replacing corporate ownership; six of the 52 plants have cooperative ownership in 1973, with additional cooperatives moving into the picture for 1974 and later. The primary impetus for the cooperative movement appears to be the growers' desire to protect the outlet for their beet crops in the face of low profitability for processing plants and the attendant prospects for plant closures. Beets as a crop have tended to produce relatively high returns in comparison with other crops; farmers are reluctant to lose their markets through plant closures.

The number of beet plants has declined steadily, from 97 in 1920 to 52 in 1973. The daily slicing capacity of the remaining 52 plants amounts to 188,862 short tons of beets. Plants range in size from 1,400 tons (daily slicing capacity) to 10,500 tons, with an average of 3,600 tons. The distribution of plants by size is as follows:

Size Range	No. Plants	Daily Capacity
Large (> 3,900 tons)	19	104,173
Medium (2,300 - 3,900 tons)	17	53,413
Small (< 2,300 tons)	16	31,276
Total	52	188,862

Beet plants are relatively old, with 38 of the plants having been built before 1933. New plants are primarily the larger plants. The plants are located in five geographic regions:

Regional Designation		No. of Plants
Region I	Great Lakes (Michigan-Ohio)	8
Region II	Red River Valley (Minnesota-North Dakota)	4
Region III	Western Plains (Nebraska, Colorado, Wyoming, Kansas, Texas)	16
Region IV	Mountains (Washington, Oregon, Montana Idaho, Wyoming, Utah, Colorado)	13
Region V	West Coast Valleys (California-Arizona)	11
		52

There are two basic technological processes used by processing plants: Straight House or Steffen House. There are 32 Straight Houses and 20 Steffen Houses. The difference in processes is that Steffen Houses further process molasses to recover additional sugar and by-products.

Annual sugar output varies among mills by the length of the operating season. Campaigns may be as short as 110 days in the Great Lakes Region and as long as 150 to 200 days in California.

The numbers of workers employed by a typical beet sugar plant is 50 full-time and 200 seasonal or part-time workers.

II. FINANCIAL PROFILE

Model plant configurations were developed for three representative sizes -- 1,750 tons (daily slicing capacity), 2,800 tons and 5,000 tons. Based on these model plants, after-tax returns on investment have been estimated for 1973 in a range of -0.4 to 9.7 percent, with after-tax return on sales of -0.2 to 4.0 percent. Beet processing is not a highly profitable industry, compared to U.S. manufacturing in general.

Annual cash flows (net income plus depreciation) for the model plants are relatively small as a result of low net incomes and low depreciation rates. Depreciation is small because plants are old and depreciation schedules are based on 30-40 years of plant life.

The industry is characterized by a high debt ratio, compared to manufacturing enterprises in general. An estimated 44 percent of invested capital consists of debt in 1973. The relatively low return on net worth (estimated at 4 to 9 percent for individual companies) helps to explain the heavy dependence on debt and suggests that the industry is hard pressed to attract new equity capital.

III. PRICING

Beet sugar prices are determined in the broader sugar market, where beet sugar and cane sugar are wholly substitutable. Domestic beet sugar must compete with domestic and impacted cane sugars as well as with other sweeteners. Beet sugar accounts for approximately 31 percent of the U.S. sugar market and 26 percent of the total U.S. sweetener market. The World sugar economy is critically important to the U.S. sugar industry. The U.S. imports about 45 percent of its total sugar supply.

Also, the Federal government has historically regulated sugar production and prices under the Sugar Act of 1948, with U.S. prices generally kept above world prices. Future sugar prices are highly uncertain, along with the future of U.S. sugar policy. World prices have risen sharply since 1966 from a low of 2.81 cents per pound to 8.53 cents in 1972. U.S. wholesale prices for refined bulk sugar in March, 1973, averaged around 12.15 cents per pound, with regional variations of ±25 percent.

IV. ECONOMIC IMPACT ANALYSIS METHODOLOGY

The funadamental methodology used in the impact analysis is the same as that normally used in capital budgeting studies of new investments. The model plant budgets provide the basic data for the analysis.

The model plants though not precisely representative of any single plant operation, reflect the financial and physical characteristics of the industry. Adjustments to model plant budgets to reflect pollution control investment and annual operating costs permit pre- and post-pollution control economic analysis for impacts on prices, profitability and production.

Probable plant closures, a key part of the analysis, are determined through a net present-value analysis, by which expected future cash proceeds are discounted at the firm's estimated cost of capital rate. A net present-value of less than zero implies that the owner would be better off to liquidate his plant and reinvest the salvage proceeds at the cost of capital rate.

Price increases required to return the plant to pre-pollution control levels of profitability are then calculated to estimate expected price effects. An evaluation of ability to pass on required price increases follows.

Finally, a qualitative analysis of economic determinants indicates the broad macroeconomic effects on agricultural production, employment, communities and balance of payments.

A detailed description of the methodology appears in Chapter IV.

V. POLLUTION CONTROL REQUIREMENTS AND COSTS

EPA provided cost estimates for incremental investment and annual operating expenses for four alternative levels of effluent controls.

Alternative A --	no waste water treatment or control effluents
Alternative B --	Retention of lime cake slurry in holding ponds. 57 percent reduction in waste load of discharged water for typical plant.
Alternative C --	Recycle of flume water with land disposal. 96 percent control of waste load.
Alternative D --	Recycle of condenser water with land disposal. 100 percent control of waste load.

From these alternatives, four sets of limitations have been constructed and evaluated for impacts.

1. Limitation of discharge to surface waters of .5 pounds BOD_5 per ton of beets processed for all plants beginning in 1977 and zero discharge in 1983.

2. Limitation of .5 pounds BOD_5 for all plants beginning in 1977; limitation of .3 pounds BOD_5 for all plants with less than 2,300 tons of daily capacity and/or with land having a soil filtration rate of 1/16-inch or less per day, beginning in 1983; zero discharge in 1983 for all other plants.

3. Zero discharge beginning in 1977 for all plants with sufficient contiguous owned land for control facilities and beginning in 1983 for plants without contiguous owned land.

4. Zero discharge beginning in 1977 for all plants.

The second condition is that which was finally adopted by EPA.

Plants currently have varying levels of controls. Six plants have no recycling, five of which are in Michigan. Twenty practice flume recycling, ten recycle both flume and condenser water but have some direct discharge, eleven are already at zero discharge and five are hooked up to municipal sewers.

Incremental costs to reach the .5 pounds BOD_5 level have been estimated for model plants. These range from $306,000 to $446,000 for investment and $41,000 to $51,000 for operating (excluding interest and depreciation) for plants currently doing no recycling.

Incremental costs to reach zero discharge for plants currently practicing flume recycling are estimated from $220,000 to $570,000 for investment and from $20,000 to $50,000 for operating.

Incremental costs for plants currently recycling both flume and condenser water but with discharge range from $49,000 to $204,000 for investment and from $3,000 to $14,000 for operation.

A key aspect of the pollution control costs is land availability and costs. Water seepage or filtration rates for various locations are also critical. Land requirements and seepage rates have been evaluated for all plants, along with availability and cost estimates. These considerations bear heavily on the impact analysis in Chapter VI.

VI. IMPACT ANALYSIS

Estimated price increases due to pollution controls are expected to be relatively insignificant. The estimated increase required to maintain profitability for the model plants at zero discharge range from 0.2 to 2.2 percent; however, the 2.2 percent estimate is for the smallest sized plant with no recycling in-place. Approximately 30 percent of the industry's current capacity is already at zero discharge and another 20 percent requires only a 0.2 percent price increase. It is unlikely that the small plants can obtain a full pass through of costs. Of course, the impact of pollution controls on cane sugar will be a factor in the beet sugar price impact. DPRA has concluded that little if any price increase will result from beet sugar controls.

Assuming no price increase, profitability is reduced for all model plants, with the reductions progressively smaller as one moves from plants with no recycling to those with flume and condenser recycling.

Using the shutdown analysis described in Chapter IV, potential closures due to pollution controls have been estimated. Plants have been evaluated on an individual basis, as well as on a model-plant basis. Closure estimates under baseline conditions and under each of the limitations conditions discussed in Chapter V have been developed as folllows:

	Range of Plant Closures	
	Minimum	Maximum
Baseline	2	6
.5 pound BOD_5 in 1977	3	5
.5 pound BOD_5 in 1977; .3 pound BOD_5 or zero discharge in 1983	4	7
.5 pound BOD_5 or land available in 1977	4	10
Zero discharge in 1977	7	17

These plants represent from 3 to 26 percent of total beet sugar production. New plants are expected to come on line to offset nearly all of the potential loss.

Employment effects are expected to be minimal, with 200 to 850 full-time and 800 to 3,400 seasonal workers affected. The effects on a given community could be greater due to the loss of growers, since each plant represents about 300 growers.

Balance of payments could be adversely affected by the loss of up to 26 percent of beet sugar production; however, new capacity coming on line, the potential closures should not materially affect the total level of raw sugar impacts.

VII. LIMITS TO ANALYSIS

While reported data are generally accurate, there is a possible range of error of ± 5 percent on price information, ± 20 percent on plant investment, ± 10 percent on plant operating costs, ± 20 percent on pollution control incremental costs and ± 15 percent on plant closures.

Two new technologies which may have potential impacts on waste water disposal are in the early stages of consideration or use by the industry. These are condensation of sugar vapor by compression and the storage of raw beet sugar juice for later refining. These technologies, which have not been evaluated, could reduce the volume of water utilized.

There were several critical assumptions on which much of the analysis rests. These include the continuation of U.S. Sugar Policy beyond the December 31, 1974 expiration date, continued resistance of beet growers to accept lower prices for their beets, little likelihood that more plants would hook up to municipal sewers, and that inflationary changes in costs and prices will be proportional. A major assumption in the final pollution control cost data is that plants meeting the .5 pounds BOD_5 level can move to the .3 level without additional cost.

I. INDUSTRY SEGMENTS

The beet sugar industry is defined under SIC 2063 as establishments primarily engaged in manufacture of sugar from sugar beets. The entire industry is well-defined with only 52 1/ operating plants owned by 10 separate operating companies.

A. Types of Firms

1. Size and Number

As indicated above, the industry is composed of ten separate firms ranging from single-plant firms to a 17-plant firm as shown in Table I-1.

In terms of sales, Great Western is largest with about $190 million annual sales. Utah and Idaho, Amalgamated, Holly, American Crystal and Spreckels each have sales ranging from $90 to $120 million annually. Michigan Sugar has annual sales of about $30 to $35 million, whereas the small single-plant firms have sales of about $750,000 to $2.0 million annually.

2. Integration and Diversification

From a traditional point of view the beet sugar industry is also unique because most of the firms in the industry are neither diversified nor integrated, excepting Great Western and Spreckels and some minor farming operations of firms like Utah and Idaho. The firms only process sugar beets into sugar.

From the viewpoint of the processor, there is little integration; however, a degree of indirect integration exists due to the nature of supply arrangements.

All sugar beets produced in the United States are grown under processor-producer contracts. Under the "price participation" provisions of these contracts, the producer is not paid a fixed price for his beets, but receives a specified share of the net returns from the sale of sugar by the processor. The share is determined on a formula basis, generally based on sucrose content of beets delivered or actual sugar yield. Thus, the participation contract results in incomes of both processors and producers being influenced by net returns in the industry.

The relationship of the beet producer and processor is becoming even closer with the recent movement of grower cooperatives into ownership of processing plants. This situation is discussed below.

1/ One plant, Mason City, Iowa, closed following the 1972-1973 campaign, leaving 52 plants in operation. Three new plants in the Red River Valley are under construction and are expected to open for the 1974-75 campaign.

Table I-1. Tons of sugar beets processed by firms 1968 and 1972

Company	No. of plants	1968, Daily tons sliced	No. of plants	1972, Daily tons sliced
Great Western	17	44,498	17	46,800
Holly	10	29,653	9	32,278
American Crystal	8	23,649	7 2/	23,774
Spreckels	5	21,400	5	21,500
Amalgamated	5	24,390	4	26,950
Utah and Idaho	5	18,600	4	21,300
Michigan Sugar	4	6,824	4	7,300
Union	1	4,800	1	4,800
Buckeye	1	1,700	1	1,700
Monitor	1	3,500	1	4,000
Maine	1	----------------N.A.----------------		
TOTAL	58	179,014 1/	53	190,402 1/

1/ Excluding Maine.

2/ This figure includes the Mason City, Iowa plant which closed after the 1972-73 campaign.

3. The Grower Cooperative Movement

By the beet sugar campaign of 1974-75, the structure of ownership of the beet sugar processing companies will have changed from the start of the 1972-73 campaign (Table I-2).

The American Crystal Sugar Company was purchased in 1973 by its respective beet grower co-op. Three new co-ops have already started construction of three new plants to be ready for processing beets at the beginning of the 1974 campaign. The Great Western Producers Cooperative negotiated with Great Western United for the purchase of its 17 plants, but in early August, 1973 the negotiations were terminated.

The primary reason for cooperative ownership and interest apparently is because the profitability of producing sugar beets versus other crop options is sufficiently great that growers are willing to assume ownership of low-return beet processing operations in order to maintain a market for the beets they produce. And, at the same time, the bargaining power of the grower co-ops on one hand and the controlled sugar prices on the other hand, have squeezed the sugar beet processing plants to a point of unattractive profitability (see Chapter II for further discussion of profitability). Each of the cooperative situations is discussed below.

The Great Western Producers Cooperative

This cooperative is the largest grower co-op. Great Western United, the owner of the sugar company, had offered to purchase Great Western's 17 sugar plants for approximately $90,000,000. Completion of this transaction had been delayed several months by law suits and requirements on the part of the lending institution that is financing 90 percent of this project. In early August, 1973, the offer and negotiations were terminated. Although a number of reasons were probably involved in the termination, it is understood that various conditions of the prospective lender could not be satisfied by the growers association.

The proposed purchase was to be financed by equity from the growers plus debt financing of $75 million out of a total capital structure of $105 million. (This amount includes funds for operating capital and certain new investments.) Interest on this debt was reported to be about nine percent for $60 million from an institutional source and 11+ percent (a floating rate based on prime plus a predetermined number of points) for $15 million from a bank. Additionally, a check-off against the growers of $1.00 per ton on future beet deliveries was proposed to retire debt.

Representations by the grower co-op to the lending institutions stated that the co-op intended to be a good neighbor, environmentally. In their financial projections, some reserves had been set up for future capital requirements to meet pollution abatement requirements, but discussions with the grower cooperative suggest that these allowances did not anticipate immediate zero discharge standards but rather were based on a standard of 2.2 kg BOD per kkg of sugar produced.

Table I-2. Beet sugar plants, ownership status, cooperatives and private firms (non co-op), 1973, 1974 and estimated 1975

Ownership	1972-73 No.	1972-73 Percent	1973-74 No.	1973-74 Percent	1974-75 No.	1974-75 Percent
Total plants	53	100	52	100	55	100
Total co-op plants	0	0	6	12	9	16
Total non co-op plants	53	100	46	88	46	84
Daily tonnage	190,802	100	188,502	100	204,502	100
Daily co-op tonnage	0	0	21,474	11	37,474	18
Daily non co-op tonnage	190,802	100	167,028	89	167,028	82

American Crystal Sugar Co.

On February 21, 1973, a merger was completed between the American Crystal growers co-op and the American Crystal Sugar Co. The money from the co-op was used to retire the corporate stock so that the co-op became the owner of the American Crystal Sugar Co. The operations are being continued under this name.

In July of 1973, the headquarters of American Crystal were moved to Fargo, North Dakota, temporarily pending the completion of construction of a new headquarter's facility in nearby Moorehead, Minnesota.

The Mason City plant was closed at the end of the 1972-73 campaign. This plant required, in addition to water pollution control equipment, considerable modernization and renovation. Two and one-half million dollars were estimated as being necessary to bring the plant up to the 2.2 kg BOD per kkg of sugar produced level. This figure included $350,000 to close the beet transport loop which would have been necessary for the plant to operate in the 1973-74 campaign.

Last-ditch efforts to raise this $350,000 through local growers were not successful and thus the plant was closed by American Crystal before the acquisition. The new ownership has apparently sustained this action. Pending water pollution control guidelines were a factor, but obsolescence and high cost of modernization of this plant were also major factors.

In the continued operation of the other six plants, the growers seem to be aware of continuing capital requirements to cover equipment needs for water pollution control and other environmental considerations.

Red River Valley Cooperative, Inc.

This co-op has raised the initial money for the construction of a 5,000-tons (sliced beets) per day plant to be operated at Hillsboro, North Dakota.

Beets will come from its grower members in Minnesota and North Dakota, with 70 percent of the beets from a 40-mile radius of the new plant and the balance within 75 miles. Fifty thousand acres have been allocated by the Sugar Division of USDA. These acres are expected to yield an average of 12.5 tons of beets per acre for a total of 625,000 tons of beets annually.

The processing plant has been designed and will be built by the BMA Machinery and Equipment Company of Denver and its parent company Braunschweigische Maschnenbauanstalt of Braunschweig, W. Germany. This plant is being built as a zero discharge water plant, using a water controlling process which is a proprietary development of the German Company.

Many U.S. sugar beet people have expressed doubt that this plant can be operated as a truly zero discharge plant in the very humid and water surplus area of the Red River Valley. However, the contractor is responsible for this specification and on the basis of world-wide experience in this field, believes it will be done. This is, of course, a position supported by the co-operative.

The total capital of the project is estimated to be $36,000 and has been raised through stock bank loans and a loan from the contractor. Fifty thousand shares each of Class A $105 per share, Class B $75 per share and Class C $76 per share, totaling $12,800,000, have been subscribed and paid or pledged by the growers on a beet sugar acreage ratio. The major financing of $20,880,000 is a loan from the St. Paul Bank for Cooperatives.

Money for working capital and for reserves for future capital requirements for water and air pollution control and energy needs seem also to have been provided for in the initial financial arrangements.

Minnesota-Dakota Co-op Inc.

This co-operative located at Wapeton, North Dakota began its venture into the financing and building of a 5,000-tons per day processing plant after the Hillsboro venture was started.

This co-op has raised its capital and has contracted with the German firm which is building the Hillsboro plant for design and construction of the same-sized plant. It will have an allotment of 50,000 acres of beets.

Therefore, these two co-operatives, at Wapeton and Hillsboro approximately 80 miles apart, are identical but separate projects.

Southern Minnesota Beet Sugar Co-op

A third new co-operative is building and will operate a processing plant 100 miles southeast of Wapeton, North Dakota, which will also be on line in 1974. This plant, designed and built by H. K. Fergeson Co. of Cleveland, Ohio, is similar to the Hereford, Texas, plant of Holly Sugar, also built by Fergeson with a 6,000-6,500-tons per day capacity.

This operation will basically use the sugar beet acreage of the now-closed Chaska, Minnesota, plant. It will feature a complete water control system calling for total containment and zero discharge. However, provision has been made to discharge excess water in a sprinkler irrigation of alfalfa acreage (200+ acres) nearby.

All adjacent land is zoned "agricultural" so that an encroaching urbanization will not threaten these plants.

This $40,000,000 project received its equity financing through the sale of shares at $108 per share to the growers of 55,000 acres of beets, based on one share for each acre of beets.

Future Developments

Facing closure of beet sugar plants and thus outlets for sugar beets, it is conceivable that sugar beet growers will take lower prices for their sugar beets or assume ownership of the best processing plants to protect their sugar beet outlet. A conclusive answer to this proposition is difficult to reach without considerable research and analytical input. This conclusion will be based on a number of factors, all reducing down to the major issue of the perceived profitability of sugar beets relative to competing crop and livestock enterprises.

Profitability measurements of competing crops require budgets for these enterprises in each of the sugar beet producing areas, assessment of risk and uncertainty factors, farmer crop preferences, investment requirements, distance to delivery points, soil and climatic resources and farm management requirements. Many farm budgets are available from secondary sources, but, unfortunately, few are directly comparable due to differences in valuation of family labor, treatment of capital costs and other variables. However, some insights can be obtained from a qualitative analysis.

Until the last six or eight months, sugar beets have been clearly more profitable than most competitive crops in areas where beets are grown. These crops include dry beans, corn, soybeans and small grains. Additionally, in the Red River Valley potatoes are a high-value and competitive crop and in North Central Coloardo, vegetables and potatoes (both high-value crops) must be added to the list of competitive crops. Incorporation of livestock enterprises utilizing farm-grown feedstuffs tend to reduce the competitive position of sugar beets.

The dramatic and recent price increases for corn and soybeans have greatly improved the position of these crops relative to sugar beets, but three other factors would suggest continued sugar beet production. These factors are:

1. Sunk investment in specialized sugar beet production equipment. This equipment and its new costs are: planter (6-row) - $1,500; thinner - $7,000; topper - $3,500 and harvester - $8,000, for a total of $20,000.

2. Unwillingness of farmers to switch quickly to new crop enterprises.

3. Use of sugar beets as an integral part of crop rotations, particularly with shallow-rooted crops.

Although sugar beets produce relatively high returns per acre (see Table I-3), it should be pointed out that sugar beets require more skilled cultural management than do other crops, such as corn. Over the years, the high hand labor requirements for thinning and weeding caused some growers to forego beet production due to the problems of securing an adequate labor supply. With the recent introduction of mechanical and

Table I-3. Returns costs and profits per acre planted by regions, 1968

	Region I	Region II	Region III	Region IV	Region V	U.S.
Production						
Beet acres per farm	40.2	125.5	84.5	71.0	191.4	81.0
Yield per planted acres (tons)	16.4	13.0	16.8	17.6	21.5	17.2
Returns						
Sale of beets	$216.0	$166.0	$237.0	$277.0	$315.0	$255.0
Sugar Act	43.0	29.0	38.0	45.0	48.0	42.0
Hauling allowed	-	2.0	1.0	1.0	9.0	3.0
Sale & use of beet tops	3.0	1.0	14.0	15.0	4.0	9.0
Total Returns	262.0	198.0	289.0	338.0	376.0	309.0
Costs						
Direct costs	139.0	96.0	148.0	219.0	210.0	164.0
Indirect Costs	37.0	22.0	35.0	42.0	45.0	36.0
Total direct & indir.	176.0	118.0	183.0	261.0	255.0	200.0
Total Rent & Interest	57.0	27.0	54.0	14.0	58.0	53.0
Costs exclusive of management	234.0	145.0	237.0	275.0		253.0
Management income	28.0	53.0	52.0	63.0	63.0	55.0

Source: USDA, ASCS Sugar Division.

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electronic beet thinners and expanded use of herbicides, the use of hand labor is decreasing, although hand labor is not yet completely replaced by new technology. These factors -- labor supply problems and additional management time -- cause some growers to discount the superior return of sugar beets in relation to competitive crops.

The dividing line on profits and preference among sugar beets and other crops is not readily distinguishable in published secondary data, and considerable farm budgeting and grower survey work would be required to establish this boundary. Differences among producing regions should be expected.

Another cost item of significance in assessing the competitive position of sugar beets is the amount of net hauling and freight costs to the grower. These costs increase with distance and at a ten-mile haul probably represent 15 to 20 percent of the growers' costs. As delivery distance for beets increases, other crops will often demonstrate improved economics due to their lesser freight and hauling costs.

Cooperative ownership of beet sugar plants can potentially change the economics of these plants, although much will depend upon the kinds of financing, particularly debt financing, which the cooperative obtains and the investment outlay which must be made for purchase of the plant.

A cooperative structure could provide certain tax advantages assuming little or no business with non-members and the ability of the cooperative to qualify for "exempt" status. In essence, the grower-patron would pay income tax on his allocated share of the earnings, whether distributed or retained in a revolving fund, at his income tax rate. In the case of a corporation structure, about 50 percent of earnings would be paid as taxes with dividends taxed again at the recipient's tax rate. The net savings in taxes will depend upon the grower's average tax rate, but likely it would be well under the 50 percent rate. Further, any dividends distributed on (preferred) stock would be taxed only once -- payable by the grower-patron.

Should a portion of the beets come from non-members, any tax advantage is quickly lost, since the cooperative must either distribute 100 cents on the dollar as patronage refunds to these non-members or pay taxes as a corporation, which would be only 50 cents on the dollar.

In practice, many farmer cooperatives choose to pay the corporate income tax rather than distribute 100 percent patronage refund to non-members. which often make up 10 to 15 percent (the maximum allowable for "exempt" co-ops is 15 percent) of their business volume. Thus, the cooperative and its members as an entity probably will have an after-tax cash proceeds equivalent to 15 to 30 cents on the dollar greater than under the corporation structure. However, this doesn't take into account the total situation, that is, the grower and processing functions. This would require inclusion of the grower's financial position in the analysis.

To address this problem properly, a rather complex analysis is required. The elements of this analysis would include:

- comparative crop-budget analysis by producing region (including non-quantitative technical and management factors)
- estimates of tax rates for sugar beet growers
- realistic assumptions on capital structure and cost of capital
- estimates on outlay for processing plants by cooperatives
- analyzing the economics from the grower's viewpoint (growing and processing as a single business enterprise) which would include beet land and equipment salvage value as well as plant salvage value and after-tax cash proceeds to the grower.

It is reported that about ten years ago Delta, Colorado, growers responded to a potential closure of the Delta plant by approaching Holly and asking what they could do to keep the plant open. This resulted in farmers raising capital for plant modernization and guaranteeing a sugar beet supply to the plant.

The current cooperative movement, purchase of American Crystal, the Great Western Sugar producers' offer to purchase Great Western and the formation of the three cooperatives in the Red River Valley -- all suggest grower interest in taking equity positions in processing. In the Red River Valley cases, it seems clear that a major motivational factor underlying the growers' actions was the profit superiority of sugar beets as a crop. These three new plants are replacing plants closed over the past ten years.

In summary, it appears quite possible that growers may acquire six to eight more beet sugar plants. The Contractor suspects the odds are in favor of cooperative takeover as opposed to the outright taking of price cuts for sugar beets. However, in the final analysis a number of factors will be involved, not least of which will be the sales price of the plants being purchased. If bought cheaply enough, and assuming some degree of modernization, a given plant could be a more attractive investment. The purchase of several plants by one cooperative is probably advantageous to single plant purchases due to improved overhead and marketing capabilities inherent in multi-plant operations.

4. Products

The beet sugar industry produces essentially one homogenous product -- beet sugar. Additionally, by-product recovery produces minor sales of pulp and molasses for animal feeds and minor quantities of Steffen filtrate for use in monosodium glutamate production.

B. Types of Plants

1. Size and Number of Plants

The number of plants processing sugar beets has declined steadily since 1920 when there were 105 plants in existence with 97 operating in that year. The trend since 1920 has been as follows:

Year	No. Operating Plants
1920	97
1930	77
1940	82
1950	72
1960	62
1968	58
1971	54
1972	53
1973	52

Capacity of sugar beet processing plants is expressed in terms of tons of beets sliced per day. Three size ranges were identifiable for classifying plants by size: large - 3,900 tons and over: medium - 2,300 tons to 3,900 tons; small - under 2,300 tons per day. The number of plants in each size range was as follows:

Size Category	Plants - 1972 No.	Plants - 1972 Daily Capacity
Large	19	104,173
Medium	17	53,413
Small	16	31,276
TOTAL	52	188,862

The range in capacity among all plants was from 1,400 tons for the smallest (Crosswell, Mich.) to 10,500 tons for the largest (Moses Lake, Wash.). Average capacity was 3,600 tons. These size ranges provided the basis for constructing the model plants used in Chapter II, with 1,750, 2,800 and 5,000 tons per day capacities to correspond to small, medium and large.

2. Age

Plants in the beet sugar industry are old with 38 of the plants being built prior to 1933 as shown in Table I-4. All of the small plants were originally built prior to 1933 as were 12 of the 17 medium sized plants. Contrasting to this, 9 of the 19 large plants have been built since 1933

Table I-4. Age and size of beet sugar plants

Region	Year built	Size			
		Small	Medium	Large	Total
		(<2,300 TPD)	(2,300-3,900 TPD)	(>3,900 TPD)	
Michigan-Ohio	Pre 1933	6	1	1	8
	Total	6	1	1	8
Red River Valley	Pre 1933		1		1
	1948		1		1
	1954		1		1
	1965			1	1
	Total	—	3	1	4
Western Plains	Pre 1933	6	8		14
	1964			1	1
	1968		1		1
	Total	6	9	1	16
Mountains	Pre 1933	3	1	5	9
	1937			1	1
	1938			1	1
	1942			1	1
	1953			1	1
	Total	3	1	9	13
California-Arizona	Pre 1933	1	1	4	6
	1935		1		1
	1937		1		1
	1947			1	1
	1963			1	1
	1966			1	1
	Total	1	3	7	11
Total	Pre 1933	16	12	10	38
	1935-1940		2	2	4
	1941-1950		1	2	3
	1950-1960		1	2	3
	1960-1974		1	3	4
		16	17	19	52

Note: Excludes Mason City, which was closed at end of 1972-73 campaign.

and five since 1950. The California - Arizona and Mountain regions are dominated by large plants, whereas the Michigan - Ohio area is dominated by small plants.

3. Location

The processing of sugar beets is a good example of a "supply-oriented" industry. Beets are bulky in relation to their value and as a result, factories are located in or adjacent to areas of production, mainly in relatively small, rural communities. The plants are usually a major enterprise in the communities in which they are located and the economic health of the plant has a major impact on economic conditions in these communities and their surrounding farming areas.

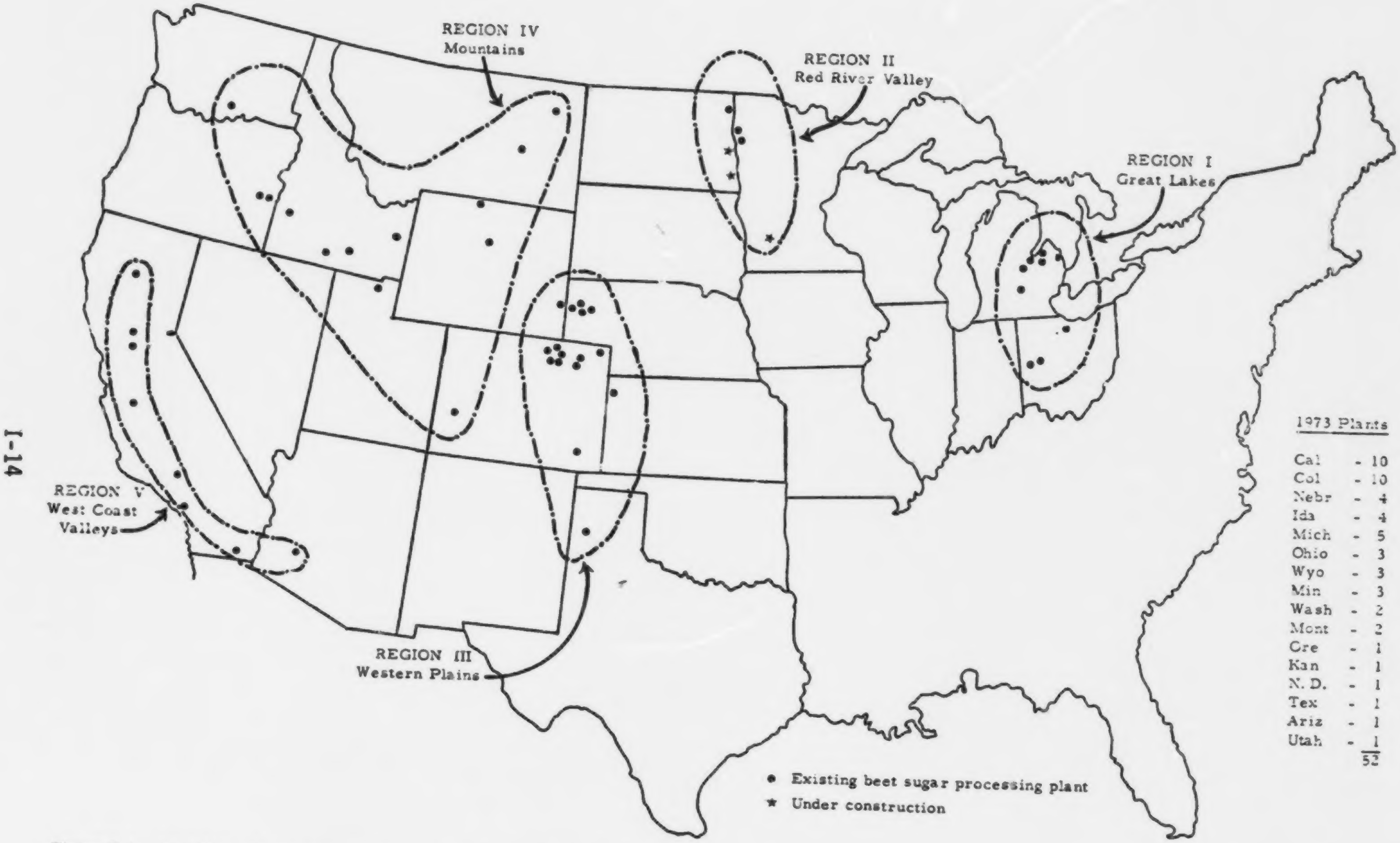
Production and processing of sugar beets in the United States is concentrated in three geographic areas: Far West Region (California, Oregon, Washington, Idaho, Arizona, Nevada), Central Region (Colorado, Iowa, Kansas, Minnesota, Montana, Nebraska, New Mexico, North Dakota, South Dakota, Texas, Utah, Wyoming), and Eastern Region (Illinois, Indiana, Ohio, Michigan, Wisconsin, New York, Maine). Figure I-1 shows the location of sugar beet processing plants in the United States. Out of the total of 52 plants shown, 12 are located in counties designated as "economic development areas" by the Economic Development Administration, U.S. Department of Commerce.

The farm production of sugar beets, by state, is as follows:

State	1971 Farm Production (000 tons beets)
California	8,212
Colorado	2,502
Idaho	3,202
Minnesota	1,613
Michigan	1,403
Washington	1,974
Nebraska	1,428
Montana	918
Wyoming	1,234
Texas	461
Oregon	464
Utah	459
Ohio	906
Arizona	218
Maine	1/
North Dakota	1,155
Kansas	688
Iowa	1/
TOTAL U.S.	26,874

1/ Not available.

Source: Crop Production, Statistical Reporting Service, USDA, January 14, 1972.


REGION IV
Mountains
REGION II
Red River Valley
REGION I
Great Lakes
REGION V
West Coast
Valleys
REGION III
Western Plains
● Existing beet sugar processing plant
★ Under construction

1973 Plants	
Cal	- 10
Col	- 10
Nebr	- 4
Ida	- 4
Mich	- 5
Ohio	- 3
Wyo	- 3
Min	- 3
Wash	- 2
Mont	- 2
Ore	- 1
Kan	- 1
N. D.	- 1
Tex	- 1
Ariz	- 1
Utah	- 1
	52

Figure I-1. Locations of sugarbeet processing plants throughout the U. S., 1973.

4. Technology and Efficiency

Two basic beet sugar processes are used in the United States. The plants are identified as either "Straight Houses" or "Steffen Houses," representative of the two processes involved. The only significant change being that "Straight Houses" (33 in number) produce molasses as a by-product which is sold, whereas the "Steffen Houses" (20 in number) further process the molasses to recover additional sugar and by-products of potassium fertilizers and monosodiumglutamates flavoring material.

In addition, numerous technological variances can be observed within each of the two processes. These variances include degree of water recycling, continuous carbonation, centrifuging and automatic control systems.

The process of extracting sugar from the beet root extends back to the farm level and involves the following steps:

1. Contracts with growers specifying cultural practices and growing, harvesting programs and delivery of beets to factory or to country receiving stations.

2. Transportation and storage of beets following delivery and prior to processing (typically beets stored 20 to 40 days except in California where warm temperatures force processors to process beets quickly, as storage in such temperatures results in deterioration of sugar content).

3. Washing the beet and removal of trash, soils, stones, etc. and slicing it into thin strips called "cossettes". (Beets are transported and washed in water.)

4. Extraction of sugar from cossettes by diffusion (essentially the cossettes are soaked in hot water causing the sugar to move from the cossettes into water). The resultant liquor is called "raw juice".

5. Exhausted cossettes (or pulp) usually pressed and dried and sold as animal feed.

6. Raw juice is treated by adding a calcium hydroxide slurry or calcium saccharate (from the Steffens process) and gassing the resulting mixture with carbon dioxide.

7. The resulting lime precipitate is separated by means of thickeners and filters.

8. The purified juice is concentrated in evaporators and then boiled under partial vacuum in a pan evaporator to crystallize sugar.

9. The resulting mixture is separated into sugar crystals and syrup by centrifugation.

10. Crystalline sugar is dried, sized, packaged and stored.

11. The remaining syrup is boiled and crystallized twice more and the final syrup is called molasses.

12. Molasses is either sold as an animal feed or desugarized by the Steffen process.

13. In the Steffen process the molasses is diluted, cooled and treated with quick lime to precipitate sugar as a saccharate.

14. The saccharate is separated by filtration and is returned to the basic system at the initial carbonation station.

15. The Steffen filtrate is normally precipitated to remove calcium carbonate and evaporated.

16. The concentrated Steffen filtrate is either dried as beet pulp or processed into monosodium glutamate or potash fertilizer salt.

Operating Season

As is characteristic of most agricultural processing industries, the beet sugar processing season or campaign is relatively short. In the Great Plains and Intermountain States, the campaign is typically 110 to 130 days duration beginning around October 1. The operating season in the northern interior regions of the United States begins in late September and early October and typically extends for about 145 days, although in some years weather conditions may allow the campaign to extend for a longer period. In California, due to the extended harvest season, the campaign is somewhat longer, reaching 150 to 200 days.

C. Number of Employees

The 1972 Census of Manufactures reported 11,500 total employees in SIC 2063, Beet Sugar, for the year 1972. The Census reported 61 establishments, with 10,400 production workers. Total annual payroll was reported as $92,300,000, including wages of $78,400,000. Forty establishments employed from 100 to 250 persons, averaging 165 total and 147.5 production employees. These data must be used with caution, however, since the number of establishments exceeds the number of plants operating in 1972 by eight.

Industry sources indicate a higher number of workers. Reports from plant operators indicate that a typical beet sugar plant has about 50 full-time, permanent employees and about 200 seasonable workers. The permanent employees include the managerial, technical and operating skilled personnel, while the seasonal group are primarily the beet-handling and product-handling workers, active only during the campaign. Using these estimates, there would be about 2,650 full-time and 10,600 seasonal employees, or 13,250 total employees in the industry.

While beet growers cannot be considered employees of the plants, it should be noted that the typical plant serves about 300 growers.

II. FINANCIAL PROFILE

A. Plants by Segment

The beet sugar industry is well-defined, with only ten firms, all of which derive their primary sales from beet sugar. Published financial information is useful in describing the industry, but to gain further insight into the financial profiles by industry segment -- process, age, and plant size -- model plant budgets were developed. Various model plant configurations were developed to represent in-place pollution control (see Chapter V for discussion), size, process and campaign variations found in the industry. Model plants were established to correspond to the small, medium and large size ranges as follows:

Model plant (Tons per day of slicing capacity)	Size range of operating plants (TPD)
1,750	<2,300
2,800	2,300-3,900
5,000	>3,900

Table II-1 summarizes the numbers of plants in each size range which are still discharging effluent into surface waters.

The results of the budget analysis are reported below, along with selected industry-wide data for comparative purposes.

1. Annual Profit Before Tax (Model Plants)

The beet sugar industry is not highly profitable. Pre-tax incomes are small--ranging from $-16,000 for the small, short-campaign plant to $1.5 million for the large, long-campaign plant (Table II-2). The pre-tax rates of return on invested capital (fixed assets plus net working capital) range from -.4 percent for the small plant up to 18.6 percent for the medium plant. After-tax rates of return are about one half of the pre-tax returns--that is, -.4 percent up to 9.7 percent. After-tax returns on sales (shown in Table II-2) range from -.1 to 4.0 percent, depending on the model.

In terms of these data, it should be noted that the medium and large plants of both configurations do not appear to be materially different in terms of ROI. The difference between the medium and large units is explained by the higher estimated depreciation and book value of fixed assets of the large units which are somewhat newer plants. Excepting two plants, all of the small and medium plants (27) were originally built prior to 1933. Of the large plants, only 10 of the 24 were originally built prior to 1933.

Table II-1. Distribution of discharging plants by region, campaign length and size 1/

Region	Size range					
	Small (<2,300 TPD)		Medium (2,300-3,900 TPD)		Large (>3,900 TPD)	
	No.	Days	No.	Days	No.	Days
Michigan-Ohio	4	145	1	145	-	-
Red River Valley	-	-	3	175	1	160
Western Plains	6	110	8	115	-	-
Mountains	3	130	1	180	7	145
California-Arizona	-	-	1	145	1	105
TOTAL	13		14		9	

1/ Five additional plants discharge into municipal systems. Three are located in Michigan-Ohio, one in California-Arizona and one in the Mountain Region. Eleven plants are at zero discharge in 1973, according to EPA.

Table II-2. Estimated income and cash flow for industry segments based on model plants

Pollution control status 1/ and plant size (TPD)	Campaign	Pre-tax			After-tax		Cash flow
		Income	ROI 2/	ROS 3/	ROI 2/	ROS 3/	
	(days)	($1,000)	(pct)	(pct)	(pct)	(pct)	($1,000)
No recycling							
1,750	110	65	1.7	1.0	0.9	0.5	156
1,750	145	329	8.8	3.8	4.6	2.0	293
2,800	145	882	16.6	6.5	8.7	3.4	581
Flume recycling only							
1,750	110	10	0.3	0.2	0.1	0.1	140
1,750	130	159	3.9	2.1	2.0	1.1	218
2,800	115	381	6.9	3.7	3.6	1.9	409
2,800	145	814	13.3	6.2	6.9	3.2	636
2,800	175	1,245	18.6	7.7	9.7	4.0	862
5,000	145	1,145	10.0	4.8	5.2	2.5	1,269
Flume and condenser recycling							
1,750	110	-16	-0.4	-0.2	-0.4	-0.2	128
2,800	115	344	6.1	3.3	3.2	1.7	403
2,800	175	1,211	17.7	7.3	9.2	3.8	856
5,000	105	-17	-0.2	-0.1	-0.2	-0.1	672
5,000	145	1,088	9.4	4.6	4.9	2.4	1,260
5,000	160	1,511	12.5	5.8	6.5	3.0	1,481

1/ See Chapter V for discussion of pollution control requirements and industry practice.

2/ Return on investment -- Invested capital equal to book value of assets, plus average investment in in-place recirculation equipment plus net working capital. Tax rate of 48 percent used throughout on assumption of multiple plant firms being in this category.

3/ Return on sales.

4/ Cash flow equals after-tax net income plus depreciation.

Pre-tax incomes from the Steffen houses were estimated to be slightly greater than from the Straight houses, but the ROI is slightly less due to the increased book value of the Steffen component. From a financial standpoint, the financial differences between the two processes appear to be immaterial; therefore, all model plant analysis will be based on Straight houses.

2. Annual Cash Flow

Estimated annual cash flow (after-tax income plus depreciation) is shown in Table II-2. The annual cash flow appears to be relatively small, particularly when compared to the high investment requirements of building new plants (up to $40 million). However, the industry is basically composed of old production facilities (although modernization and expansion have occurred). Further, depreciation schedules have been set up on very long lives, generally 30 to 40 years, reflecting the seasonal use pattern. This slow depreciation, plus low profit levels, produces a small cash flow in an industry where replacement costs are high. The situation is particularly apparent in the small plants where cash flow is estimated to be only $130,000 to $160,000 per year.

3. Market and Salvage Values of Assets

The valuation of assets in beet sugar processing can be viewed as (a) market or (b) salvage values.

Market Value of Plants--One estimate of the value of beet sugar plants is the current replacement cost of assets. This estimate (Table II-3) represents the cost of constructing an operable processing plant. General items included are site and site preparation; buildings, including office and warehouse space for storage; equipment, both processing line and handling and other, such as pallets, trucks, etc. Land costs are estimated at $1,000 per acre for the model plant sites. The estimates exclude investment in pollution control facilities for achieving zero discharge.

Replacement values in factory and related facilities are large. The estimates range from $16.8 million for a 1,750-tons per day Straight house up to $34.9 million for a 5,000-tons per day Straight house. Addition of the Steffen process equipment entails about $4.0 million additional investment, largely in equipment.

Over 50 percent of the plant outlay is in equipment. Most of this equipment represents specialized custom-built processing machinery, which means that the labor component is quite high--perhaps 50 to 60 percent. Engineering and construction facilities represent about eight percent. Thus, even as a new plant, fixed asset value in terms of liquidation is probably less than 50 percent of capital outlay.

Table II-3. Estimated replacement investment and book value of assets for model plants - exclusive of pollution control

Item	Straight House			Steffen House	
	1,750	2,800	5,000	2,800	5,000
	(Tons of beets sliced per day)				
		--1,000--			--1,000--
Plant Replacement					
Factory yards 1/ & equipment	$ 3,880	$ 5,250	$ 7,780	$ 5,250	$ 7,780
Buildings	2,010	2,730	4,040	2,930	4,340
Processing	8,360	11,350	16,780	13,510	19,800
Temporary construction facilities	390	520	780	520	780
Engineering and design	80	100	160	120	170
Contingencies and other	780	1,050	1,560	1,170	1,730
Remote receiving stations	1,300	2,100	3,800	2,100	3,800
Total plant investment	$16,800	$23,100	$34,900	$25,600	$38,400
Book Value					
Book Value - plant	$ 2,450	$ 3,200	$6,300	$ 3,600	$ 6,900
Total working capital	2,900	4,700	8,400	5,300	9,500
Net working capital	1,300	2,100	3,700	2,400	4,200

Source: Developed from current industry estimates, published financial data and Young, Robert A., An Economic Study of the Eastern Beet Sugar Industry, RB 9, Mich. State Agric. Exper. Stat. 1965 - with DPRA interpretations.

1/ Includes land costs at $1,000 per acre as follows:

1,750 TPD	$ 53,000
2,800 TPD	76,000
5,000 TPD	108,000

Another estimate of asset value is the accounting concept, "book value". Due to the well-defined nature of the industry, examination of company financial data permits estimates of fixed asset book value by plant size. Several of the firms have all small plants or all large plants, making this speculation possible. As shown in Table II-3, the estimated book value of assets is low in comparison to replacement cost -- 14 percent for the small and medium-sized model and 18 percent for the large configuration. Book value ranges from $2.4 million to $6.9 million versus replacement values of $16.8 to $38.4 million. Those differences reflect the older age of small and medium-sized plants as discussed above.

An important component of investment values is net working capital (current assets minus current liabilities). Although total current assets and liabilities vary by firm and year, the industry generally has current assets of 45 percent of sales and current liabilities of 25 percent of sales. Net working capital of 20 percent of sales is large, but considering the short seasonal nature of beet production and the short processing period (3 to 6 months), a high working capital requirement should be expected. It includes inventories, prepaid beet costs plus the other normal items of receivables and cash, less payables and short-term debt.

Salvage Values--In the past four years a total of six beet sugar plants have closed for various reasons. Exact salvage values are not available, since each plant has had its own special problems and special salvage value. Table II-4 sets forth some of the data concerning values, disposition of assets and what happened to the beet acreage and the employees.

In terms of alternative uses, the value of fixed assets would appear to be less than book, since with the low profitability of the industry, as shown in Table II-2 above, further shutdowns would be expected. This suggests that the liquidation value of assets is less than 15 percent of replacement costs for a similar sized plant. Liquidation value of assets would probably be about 25 percent of book value. This includes a 100 percent market value of land at $1,000 per acre, two percent of equipment replacement and five to ten percent of building replacement costs.

Recovery or release of working capital on the other hand through closure would appear to be of more significance. With an indicated net working capital of 20 percent of sales, the amount by plant would range from $1.3 million for the small plants up to $5.0+ million for the large plants. Net working capital would probably be 100 percent recoverable.

Based on these relationships, Table II-5 presents estimated salvage values. The estimates for plants with facilities for the recirculation of waste water presume a value of $1,000 acre for the land in ponds and no direct value for the recirculation equipment.

Table II-4. Sugar beet plant closings, 1968-1973

Plant and Owner	Beets sliced (TPD)	Type plant	When closed	Salvage or Use	Beet acreage utilization	Employees laid off
W. Jordan, Utah U&I Sugar	1,600	Straight	'71	Now used for sugar terminal and for making liquid sugar	50% beets now shipped to Garland plant	45 permanent 250 seasonal
Easton, Maine Maine Sugar Industries, Inc.	4,000	Straight	'68 or '69	Could be used for potato handling	Yield for beets was low 6 ton/ac. May be better for potatoes	NA
Lewiston, Utah Amalgamated Sugar Co.	1,800	Steffen	'72	Mostly land salvage only. Charge off on statement $800,000	Beets now go to Mini-Casia Plant	40 permanent 25 transferred
Hardin, Mont. Holly Sugar	1,700	Straight	'70	Cancellation of Self Insurance Credit $164,000. Presumably land is major salvage value	Growers changed to wheat and safflower	50 permanent 180 seasonal 12 transferred
Chaska, Minn. American Crystal Sugar Go.	2,000	Steffen	'70	Estimated to be $2,000,000	One-half acreage may by '74 be used at new plant pending Renville, Minn. 85 miles west	NA
Mason City, Iowa American Crystal Sugar Co.	2,300	Straight	'73	Estimated to be $2,000,000	Part of beet acreage may go to new Renville, Minn. for 1974 campaign	NA

Table II-5. Estimated salvage value for Straight house beet sugar plants

Slicing Capacity	Campaign	Recirculation Facilities	Fixed Assets	Net Working Capital	Total
(TPD)	(days)	(type)	- - - - - - $1,000- - - - - - - - -		
1,750	110	1	600	1,270	1,870
	110	2	640	1,270	1,910
	110	3	640	1,270	1,910
1,750	130	2	650	1,500	2,150
1,750	145	1	600	1,680	2,280
2,800	115	2	870	2,130	3,000
	115	3	870	2,130	3,000
2,800	145	1	800	2,680	3,480
		2	880	2,680	3,560
2,800	175	2	910	3,240	4,150
	175	3	910	3,240	4,150
5,000	105	3	1,710	3,470	5,180
5,000	145	2	1,750	4,780	6,530
	145	3	1,750	4,780	6,530
5,000	160	3	1,770	5,280	7,050

Note: 1 - no recirculation
2 - flume recirculation
3 - flume and condenser recirculation

4. Cost Structure

Fixed costs are relatively small -- amounting to only 10 to 12 percent of sales. The costs include property taxes, insurance, repairs and maintenance, G & A, depreciation and interest. Although minor economies of size are shown in fixed expenses, these differences are obscured by variances in depreciation.

Variable (or direct) costs as a whole are relatively high, with two items, beet purchases and marketing, heavily influencing these costs. Beet-purchase costs represent about 55 to 60 percent of total direct costs and just over 50 percent of sales. It should be noted that under the unique grower-processor agreements, the grower receives a fixed percentage share of the net proceeds from the processor. These net proceeds are generally the gross sugar value less marketing expenses of bagging, storing, transporting, selling, federal excise taxes, etc., although regional and company variations exist. Another variable involved in the beet price equation is the sugar content of the grower's beets; beets with high sugar content are worth more per ton than those with a low sugar content.

The price of sugar used in the model plant analysis was $12.15 per hundredweight, which approximates the 1972 price as estimated by USDA for the United States. As shown in Chapter III, prices have trended upward in recent years. Pulp and molasses sales were estimated to be 10 percent of the value of sugar, which represents the historical relationship. With the recent strong demand for animal feedstuffs, prices for these goods have drifted upward; however, pulp and molasses' prices have probably risen in pace with sugar prices.

5. Cost Estimate

The estimated costs of production shown in Table II-6 were made from synthesized data developed from industry sources, published financial data and the few published cost studies available.

The physical inputs and relationships for beet sugar processing are relatively extensive and subject to considerable plant-to-plant variation. Processors, due to competitive relationships within the industry and the need to negotiate annual contracts with beet growers, do not release specific plant cost data.

As can be seen in Table II-7, the Steffen house requires additional production labor, limestone, fuel and other supplies. Size economies of physical inputs are evident in production labor and fuel. It should be noted that beet receiving and transportation cost per ton is shown as a constant per ton. It has been our experience in agricultural processing industries that thi cost increases per ton as plant size increases due to

Table II-6. Estimated pro forma income and expense statement for selected plants (straight) with flume recirculation in place

	1,750 TPD (110 days)	2,800 TPD (115 days)	5,000 TPD (145 days)
		$1,000	
Revenue	6,355	10,629	23,925
Direct expenses	5,514	8,950	19,826
Indirect expenses	590	934	1,976
Pollution expenses	42	47	65
Total	6,146	9,931	21,867
Cash earnings	209	698	2,058
Depreciation	122	196	650
Depreciation-pollution	13	15	24
Interest	64	106	239
Total	199	317	913
Pre-tax income	10	381	1,145
After-tax income	5	198	595
Depreciation	135	211	674
Cash flow	140	409	1,269
Assets-book	2,450	3,200	6,300
Pollution-book 1/	153	196	330
Net working capital	1,270	2,130	4,780
Invested capital	3,873	5,526	11,410

1/ Estimated as new investment divided by two.

Table II-7. Estimated input-output requirements and costs used in model plant analysis

Item	Straight House			Steffen House	
	1,750	2,800	5,000	2,800	5,000
	(Tons of beets sliced per day)				
Beets purchased (lbs/ton sliced	2,060	2,060	2,060	2,060	2,060
Beets sliced (lbs/ton sliced)	2,000	2,000	2,000	2,000	2,000
Beet purchase	65% on net sugar proceeds (gross price less marketing cost)				
Production & related labor[1] (man hours/ton sliced)	.65	.50	.43	.57	.50
Limestone [2] (tons/ton sliced)	.04	.04	.04	.06	.06
Fuel [3] (BTU's/ton sliced)	2.9×10^6	2.5×10^6	2.3×10^6	3.1×10^6	2.9×10^6
Power and water ($/tons sliced)	.95	.85	.78	1.05	1.00
Beet assembly ($/ton sliced)	1.95	1.95	1.95	1.95	1.95
Property taxes & insurance	Book value of fixed assets x 60 mills				
Other supplies[3] ($/ton sliced)	.30	.30	.30	.35	.35
Repairs & maintenance ($/ton sliced)	1.15	1.15	1.05	1.30	1.20
General and administrative and other [4]	3.5 percent x sales				
Sugar extracted (cwt/ton sliced)	2.47	2.47	2.47	2.78	2.78
Beet pulp and molasses	10 percent x gross sales of sugar				
Depreciation ($/ton slicing capacity)	70	70	130	78	143
Interest	1.0 percent of total sales				

---

[1] Costed at $3.50 per hour.

[2] Costed at $5.00 per ton

[3] Costed at $.575 per 10^6 BTU's

[4] Includes filters, sulfur and other minor inputs

[5] Includes general and plant management, agricultural department, and related expenses. Excludes depreciation and debt service.

Source: Developed by DPRA from industry discussions, published financial data, Young, Robert A., An Economic Study of the Eastern Beet Sugar Industry, RB 9, Mich. State Agric. Exp. Sta., 1965, "State-of-Art, Sugarbeet Processing Waste Treatment," and Lof, G. O. G., and Allen J. Kneese, The Economics of Water Utilization in the Beet Sugar Industry, Resources for the Future, Inc., 1968 and unpublished data from the Sugar Division, ASCS, USDA.

diseconomies associated with larger supply areas, but the extent of this was not ascertained. Depreciation and interest relationships were developed from an analysis of company annual reports and a comparison of the characteristics of plants owned by each company with other companies. For instance, Michigan Sugar has small, old plants, while U & I and Amalgamated tend to have larger, newer plants.

The typical input-output relationships of sugar, beet pulp and molasses are shown in the lower portion of Table II-7. The actual relationship will vary from year to year and from factory to factory depending on the sucrose content of the beets, the purity of the beet and factory operating policy with reference to additional boiling of molasses. For purposes of this analysis, typical sugar extraction rates were placed at 2.47 hundredweights per ton for Straight houses and 2.78 hundredweights for Steffen houses.

Table II-8 summarizes the cost estimates for selected plants in returns and costs per hundredweight of sugar. These costs exclude any in-place recirculation facilities.

B. Ability to Finance New Investment

The ability of a firm to finance new investment for pollution abatement is a function of several critical financial and economic factors. In general terms, new capital must come from one or more of the following sources: (1) funds borrowed from outside sources; (2) new equity capital through the sale of new common or preferred stock; (3) internally generated funds -- retained earnings and the stream of funds attributed to depreciation of fixed assets.

For each of the three major sources of new investment, the most critical set of factors is the financial condition of the individual firm. For debt financing, the firm's credit rating, earnings record over a period of years, stability of earnings, existing debt-equity ratio and the lender's confidence in management will be major considerations. New equity funds through the sale of securities will depend upon the firm's future earnings as anticipated by investors, which in turn will reflect past earnings' records. The firm's record, compared to others in its own industry and to firms in other similar industries, will be a major determinant of the ease with which new equity capital can be acquired. In the comparisons, the investor will probably look at the trend of earnings for the past five or so years.

Internally-generated funds depend upon the margin of profitability and the cash flow from operations. Also, in publicly held corporations, stockholders must be willing to forego dividends in order to make earnings available for reinvestment.

Table II-8. Estimated sales, expenses and before-tax income per hundredweight of sugar for selected model plants without recirculation facilities

	Straight House			Steffen House	
	Small	Medium	Large	Medium	Large
	(110 days)	(115 days)	(145 days)	(115 days)	(145 days)
Sales					
Sugar	$12.15	$12.15	$12.15	$12.15	$12.15
Pulp and molasses	1.22	1.22	1.22	1.22	1.22
Total	$13.37	$13.37	$13.37	$13.37	$13.37
Direct Costs					
Beet purchase	$ 6.60	$ 6.60	$ 6.60	$ 6.60	$ 6.60
Beet assembly	.81	.81	.81	.72	.72
Production and related labor	.92	.71	.61	.72	.63
Limestone	.08	.08	.08	.11	.11
Fuel	.68	.58	.54	.64	.60
Power and water	.38	.34	.32	.38	.36
Other supplies	.12	.12	.12	.13	.12
Marketing	2.00	2.00	2.00	2.00	2.00
Total	$11.59	$11.24	$11.08	$11.30	$11.14
Indirect Costs					
Property taxes and insurance	.31	.24	.21	.24	.21
Repairs and maintenance	.46	.47	.43	.47	.43
General and administrative	.47	.47	.47	.47	.47
Subtotal	$1.24	$1.18	$1.11	$1.18	$1.11
Depreciation	.26	.25	.36	.24	.35
Interest	.14	.14	.14	.14	.14
Subtotal	$ .40	$ .39	$ .50	$ .38	$ .49
Total	$13.23	$12.81	$12.69	$12.86	$12.74
Before tax income	.14	.56	.68	.51	.63

The condition of the firm's industry and the general economy are also major limiting factors in attracting new capital. The industry will be compared to other similar industries (other manufacturing industries) in terms of net profits on sales and on net worth, supply-demand relationships, trends in production and consumption, the state of technology, impact of government regulation, foreign trade and other significant variables. Declining or depressed industries are not good prospects for attracting new capital. At the same time, the overall condition of the domestic and international economy can influence capital markets. A firm is more likely to attract new capital during a boom period than during a recession. On the other hand, the cost of new capital will usually be higher during an expansionary period. Furthermore, the money markets play a determining role in new financing; the 1973 year has been viewed as especially difficult for new equity issues.

These general guidelines can be applied to the sugar beet industry by looking at general economic data, industry performance and available corporate records.

The general economic outlook for the next few years is for continued economic expansion at the historic 3.5 percent annual rate, expressed in constant dollars. The 1973 rapid growth shows evidence of slowing in the latter part of the year. In spite of cyclical fluctuations, the American economy should sustain its long-term growth through the 1974-77 period. Inflation and unemployment will undoubtedly continue as major problems and international economic affairs will exert significant pressures on the domestic economy. Demand for capital will remain high in relation to supply and interest rates will probably stay high by historic stands. The cost of financing new investment will be high compared to the 1950's and early 1960's.

Although there are substantial variations by firm in profits, profits overall have been drifting downward in the beet sugar industry. As shown in Figure II-1, after-tax returns on sales have declined to a current level of about 2.0 to 3.0 percent, although Amalgamated demonstrates a much stronger position with profits on sales of about 5.0 percent. Even in this case, returns are down significantly from 1965 levels.

A similar picture emerges when the return on net worth is examined (Figure II-2). Presently, return on net worth appears to be 4.0 to 9.0 percent. This places the beet sugar industry well below the manufacturing average of 12 percent and among the lowest of all industry segments. This same low return situation is shown with the model plants discussed above.

Long-term debt in the industry varies widely, ranging from 0.07 of equity for Amalgamated to 0.13 for Utah and Idaho and to 0.45 for Michigan Sugar, 0.35 for American Crystal and 0.45 for Holly. Excepting Amalgamated and U & I, the fixed debt-to-equity ratio appears to be at the upper limit

Figure II-1. Return on sales selected beet sugar companies

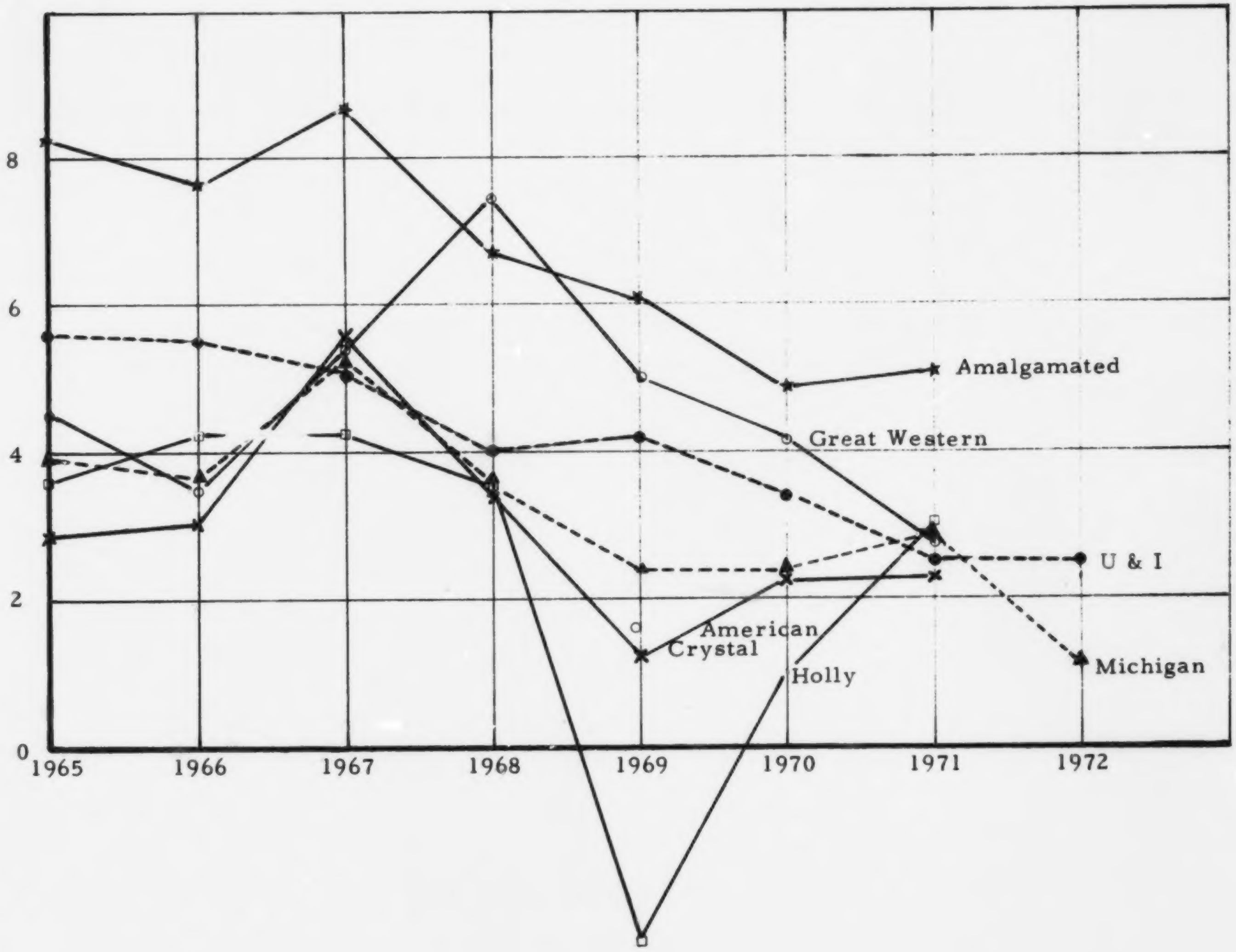
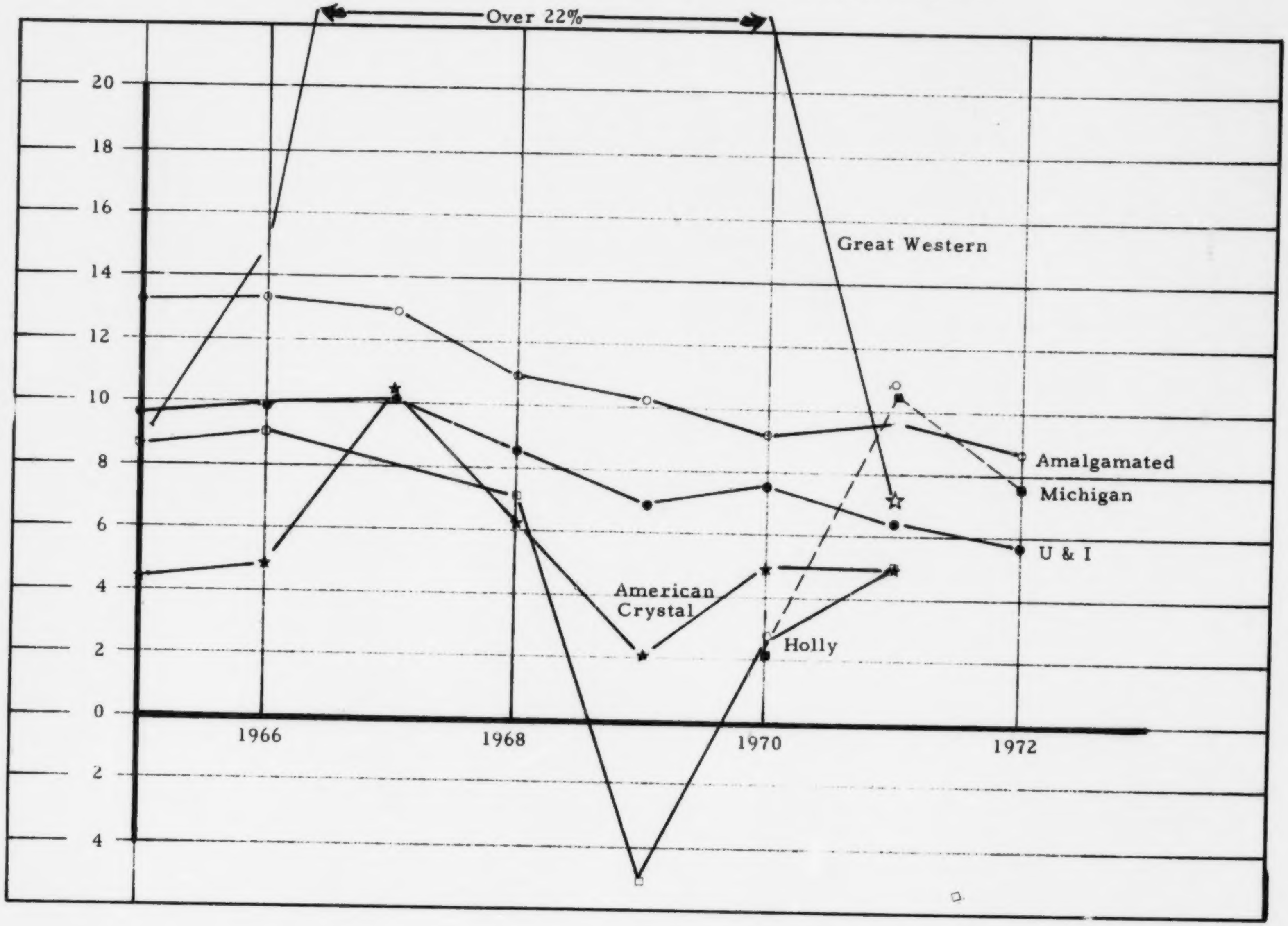


Figure II-2. Return on investment selected beet sugar companies



when compared to typical manufacturing debt-equity ratios of 35 to 40 percent. Reports on the cooperative movement suggest that the debt ratio will likely be higher for the cooperatives than for existing corporate ownerships. For instance, the proposed Great Western acquisition was based on a 75 percent debt ratio. The Red River Valley Cooperatives, Inc. has about a 58 percent debt ratio and the Southern Minnesota Beet Sugar Cooperative is reported to have a debt ratio in excess of 80 percent.

Considering the rule of thumb of 2:1 for an adequate current ratio 1/, the beet sugar industry would appear to be a bit weak, although not serious. For instance, Michigan Sugar has a current ratio of about 2.5 (1971) and Holly Sugar, Great Western, American Crystal and U & I are somewhat lower, with a ratio of about 1.6, depending on valuation of inventories. Amalgamated, on the other hand, had a current ratio of 3.2 during the past two years - 1971 and 1972.

In terms of total asset relationships, the industry has an estimated equity to total asset ratio of 0.56 and debt to total asset ratio of 0.44. Amalgamated has a 0.75 equity to total asset ratio, while U & I, Michigan and Holly have a 0.48 ratio and American Crystal has a 0.60 ratio.

Market price of common stock in the industry as a multiple of earnings per share (price-earnings ratio) is about 12 over the last two years. Most publically traded firms fall close to this average, excepting Michigan Sugar, which had a P/E ratio of 28.

The combination of low and declining earnings with a high debt-equity ratio suggests that the beet sugar industry is hard pressed in its ability to attract capital.

This situation would appear to be borne out by the recent grower co-op acquisition movement, at a time when normal risk capital is not entering the industry. As described in Chapter I, the grower co-op movement appears to be motivated by a desire to protect outlets for raw sugar beets (an attractive farm enterprise) rather than an interest in income from processing and marketing. Conversely, it would also appear that beet sugar management is moving in this direction as a means of raising capital, since the growers are pledging capital in proportion to their beet acreage.

With the high debt-ratio and the relatively low cash flow (see above), imposition of new capital requirements, particularly non-productive pollution control equipment and facilities, raises serious questions

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1/ Current assets to current liabilities.

regarding the ability of a large component of the corporate industry to raise the required funds. The picture regarding the co-op (or prospective) sector is less clear, since if required, it seems likely that the grower-members will raise capital to protect their beet market. The limits of this source are not known.

C. Cost of Capital - After-Tax

An estimated cost of capital (after-tax) has been derived from an analysis of the financial reports of the publicly-held companies and from unpublished industry data. Two methods have been used -- the dividend-yield and the earnings-stock price (E/P) methods. Both are simplifications of the more complicated DCF methodology (see Chapter IV for further discussion).

The dividend-yield method is:

$$k = \frac{D}{P} + g$$

where

k = cost of capital
D = dividend per share of common stock
P = market price per share of common stock
g = growth in earnings per share

and the E/P method is simply

$$k = E/P$$

where

E = earnings per share of common stock
P = market price per share of common stock

and is a further simplification of the first. The latter assumes a level, perpetual stream of future earnings. In order to calculate an estimated cost of capital for the beet sugar processing industry, several industry ratios have been computed from available data. These are as follows:

Equity to total capital	0.56
Long-term debt to total capital	0.44
Dividend yield (D/P) -- 5 year average	0.58
Earnings/price (E/P) -- 5 year average	0.081

Interest on long-term debt has been estimated at 7.5 percent 1/, which has an effective after-tax cost of 3.9 percent (assuming a 48 percent tax rate). Growth in earnings has been estimated at 4 percent per annum, a figure roughly equal to the annual rate of inflation from 1969 through 1973.

Using the foregoing estimates, the average cost of capital for the beet sugar industry is as follows:

Dividend Yield Plus Growth

Capital	Weight	Cost	Growth	Weighted Cost
Equity	.56	.058 (D/P)	.04	.055
Debt	.44	.039	--	.017
Weighted average cost of capital				.072

Earnings-Price

Capital	Weight	Cost	Weighted Cost
Equity	.56	.081 (E/P)	.045
Debt	.44	.039	.017
Weighted average cost of capital			.062

As shown in the above computations, the estimated after-tax cost is 6.2 to 7.2 percent. The subsequent analysis was based on 6.0 and 7.5 percent. The upper estimate presumes a four percent growth factor which is roughly equal to inflation expectations.

Some beet sugar firms report that they use a pre-tax cost of capital of 15 percent for evaluating new projects. This is only slightly higher than the above estimated after-tax costs.

1/ The 7.5 percent rate is the estimated average embedded debt cost for the industry. New debt carries a higher rate; however, older debt at rates below 7.5 percent produces an average cost well under current interest rates.

III. PRICING

Beet sugar processors are one of two main components of the sugar industry, which is part of the larger sweetener sector of the U.S. food system. Sugar (sucrose) can be either beet sugar or cane sugar, with cane sugar accounting for more of the domestic market (see Figure III-1).

There are fundamental differences in the structure of beet and cane sugar manufacturing. Sugar beet processors contract with beet growers to buy the growers' production. The beets are then processed into refined sugar and by-products such as molasses, monosodium glutamate, and beet pulp. Sugar cane, raised in more tropical climates, is first milled to produce raw sugar. This is the form of most imported sugar. Cane sugar refiners use domestically produced and imported raw sugar to produce refined sugar.

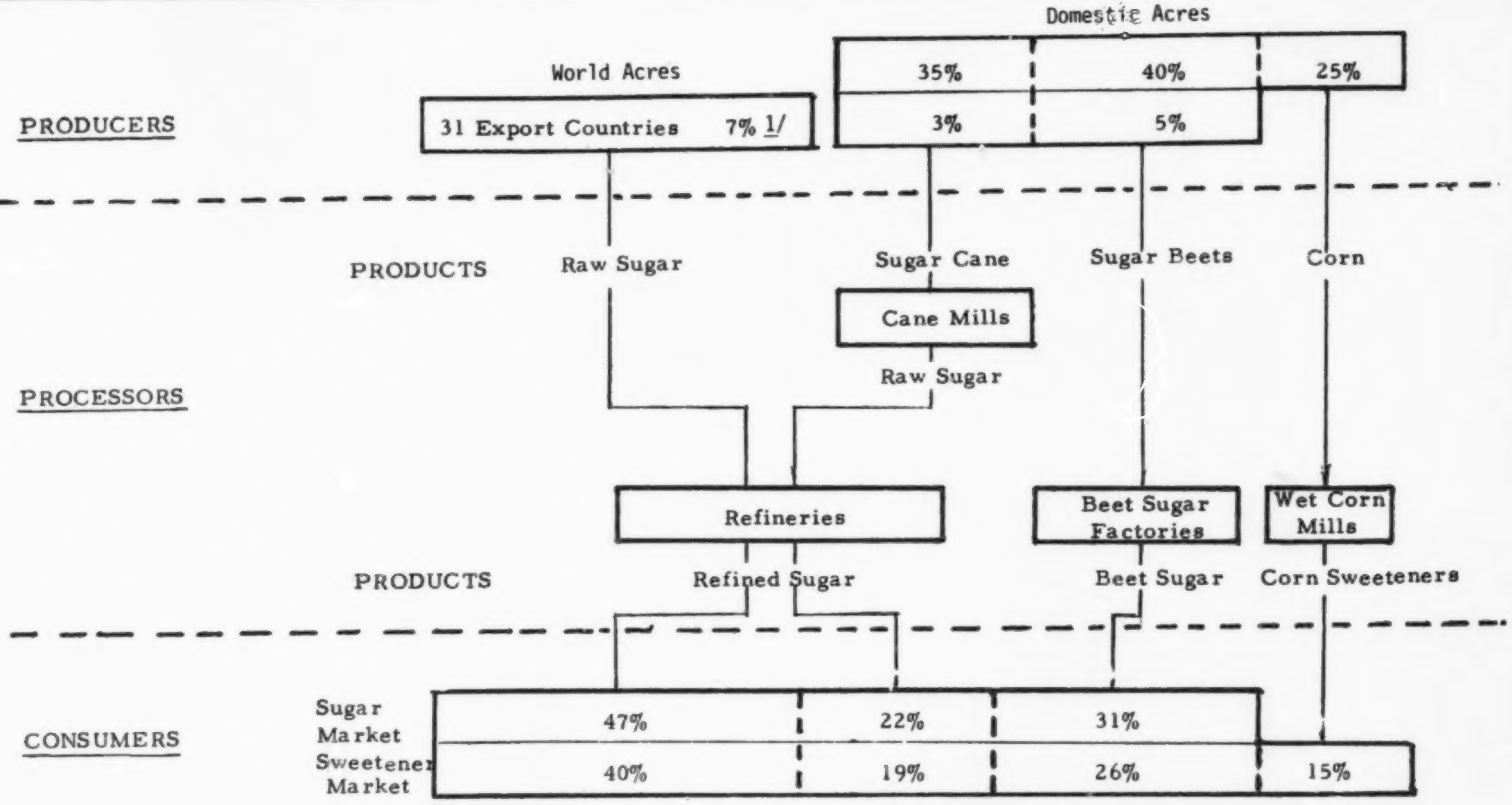
Refined beet sugar and cane sugar compete as perfect substitutes in the wholesale market. Through a quota system the government regulates the production and importation of sugar so as to stabilize and maintain prices at specified levels. Refined sugar is marketed by refiners and processors under a system of base-point pricing. It will be shown that the structure of the sugar industry and sugar policy provide possible limitations on the sugar processors' ability to shift the cost of additional pollution abatement to the consumers in the long run.

A. Price Determination

1. Demand

All but a small fraction of domestic sugar consumption is for human food. U.S. per capita sugar consumption (Table III-1) has been fairly stable since the 1930's, ranging between 90 and 100 pounds. Recent increases above 100 pounds are attributed to the Food and Drug Administration restrictions on use of cyclamates. Sugar and corn sweeteners (corn syrup and dextrose) are known as nutritive sweeteners while cyclamates and saccharine are called noncaloric sweeteners. About two-thirds of all sugar is consumed in industrial uses, especially by food processing industries. Only one-fourth is purchased for home use -- kitchen and table. The remainder is used in restaurant and institutional meal preparation.

Industrial uses for sugar are mainly in food processing with minor other industrial uses (Table III-2). The beverage industry is the largest user of sugar and has made little use of corn sweeteners as a substitute for sugar. The beverage industry is also the highest user of noncaloric sweeteners. Baking, the next largest user, has dropped its use of sugar


Domestic Acres
World Acres
PRODUCERS
31 Export Countries 7% 1/
35%
40%
25%
3%
5%
PRODUCTS
Raw Sugar
Sugar Cane
Sugar Beets
Corn
Cane Mills
Raw Sugar
PROCESSORS
Refineries
Beet Sugar Factories
Wet Corn Mills
PRODUCTS
Refined Sugar
Beet Sugar
Corn Sweeteners
CONSUMERS
Sugar Market
Sweetener Market
47%
22%
31%
40%
19%
26%
15%

1/ Estimated percentage of total world acres used to produce U.S. raw sugar imports.

Figure III-1. Structure of the domestic sweetener industry.

Table III-1. Trends in per capita distribution of nutritive sweeteners and the share that each sweetener represents of the total distribution, 1956-71

Calendar year	Nutritive sweeteners	Sugar	Corn sirup	Dextrose	Percent of total nutritive sweeteners: Sugar	Corn sirup	Dextrose
	Pounds per capita refined				Percent		
1956	110.8	98.7	8.3	3.7	89.1	7.5	3.4
1957	106.4	94.6	8.2	3.6	88.9	7.7	3.4
1958	109.8	96.9	8.7	4.1	88.3	8.0	3.7
1959	109.9	96.4	9.1	4.3	87.7	8.2	3.9
1960	110.9	97.5	9.3	4.1	87.9	8.4	3.7
1961	111.6	97.7	9.7	4.2	87.5	8.7	3.8
1962	113.1	98.0	10.7	4.4	86.6	9.5	3.9
1963	113.7	97.6	11.1	5.0	85.8	9.8	4.4
1964	113.3	96.2	12.2	4.9	84.9	10.8	4.3
1965	113.6	96.6	12.2	4.8	84.9	10.8	4.3
1966	115.3	98.1	12.5	4.7	85.1	10.9	4.0
1967	114.5	97.2	12.6	4.6	84.9	11.0	4.1
1968	117.7	100.2	12.8	4.7	85.1	10.9	4.0
1969	118.1	100.3	13.0	4.8	84.9	11.0	4.1
1970	121.0	102.5	13.1	5.4	84.7	10.8	4.5
1971	122.3	102.9	13.7	5.7	84.1	11.2	4.7
1956-67 trend	+.61	+.04	+.46	+.11	-.44	+.37	+.08
1968-71 trend	+1.67	+1.03	+.28	+.36	-.32	+.07	+.25
1956-71 trend	+.84	+.34	+.39	+.11	-.34	+.28	+.06

Source: USDA, ASCS, Sugar Report.

Table III-2. Sugar deliveries, by type of sugar and by type of product or business of buyer, calendar year 1971. [1]

Product or business of buyer	Beet	Cane	Imported direct consumption	Total all sugar	Liquid sugar included in totals	
					Beet	Cane
	Hunderedweights [2]					
Industrial						
Bakery, cereal and allied products	9,847,388	17,115,774	161,348	27,124,510	292,403	2,377,746
Confectionery and related products	6,653,051	14,236,521	156,920	21,046,492	167,552	3,269,348
Ice cream and dairy products	4,074,342	7,001,147	49,445	11,124,934	2,150,928	4,783,993
Beverages	11,926,601	35,310,248	50,103	47,286,952	5,831,266	22,768,934
Canned, bottled, frozen foods, jams, jellies and preserves	9,458,478	11,004,504	111,587	20,574,569	3,564,693	5,325,399
Multiple and all other food uses	4,003,454	5,855,962	58,025	9,917,441	269,138	1,585,445
Non-food products	282,605	1,537,700	40,276	1,860,581	54,002	581,339
Sub-total	46,245,919	92,061,856	627,704	138,935,479	12,329,982	40,692,204
Non-industrial						
Hotels, restaurants, institutions	98,375	1,455,605	33,566	1,587,546	12,868	100,862
Wholesale grocers, jobbers, sugar dealers	12,522,604	30,132,194	542,662	43,197,460	345,371	311,983
Retail grocers, chain stores, super markets	4,799,114	21,031,042	750,163	26,580,319	116,833	227,642
All other deliveries, including deliveries to Government agencies	591,438	1,309,258	2,588	1,903,284	100,841	81,350
Sub-total	18,011,531	53,928,099	1,328,979	73,268,609	575,913	721,837
Total deliveries	64,257,450	145,989,955	1,956,683	212,204,088	12,905,895	41,414,041
Included in totals:						
Deliveries in consumer-size packages (less than 50 lbs)	9,591,717	41,954,005	652,985	52,198,707		
Deliveries in bulk (unpackaged)	25,318,587	34,622,624	144,527	60,085,738		

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[1] Represents approximately 100.0 percent of deliveries by primary distributors in continental United States.
[2] Reported as produced or imported and delivered except liquid sugar which is on a sugar solids content basis.

Source: USDA-ASCS, Sugar Reports, No. 238 (March, 1972), p. 14.

from 80 percent of total nutritive sweeteners in 1956 to less than 74 percent in 1972. Sugar's share of confectionery demand for nutritive sweeteners has been more stable, declining from 70 percent in 1956 to 68 percent in 1972. Although sugar's share of canning demand has fallen from 87 percent in 1956 to 82 percent in 1972, its share has risen since hitting a low in 1967. During the period from 1956 to 1972, the price of corn sweeteners has fallen relative to sugar and new production techniques have improved the quality of corn syrup.

As shown above, some substitution among sweeteners exists. Noncaloric sweeteners are used to meet the demands of those consumers seeking to limit sugar intake. Some substitution of noncaloric sweeteners for sugar is associated with relative price changes. However, for noncaloric sweeteners quality considerations appear to be more important. Corn sweeteners are sugar's major price competitor. Technical improvements in corn syrup manufacture have produced a range of syrups of different qualities. Thus, corn syrup is better able to meet the different specifications of users. A limiting factor is the fact that corn syrup is less sweet than sugar. However, research in improving corn syrup's sweetness is promising.

The development of high levulose (fructose) corn syrups by new processes from Japan show great promise of having a significant impact on the U.S. market for sweeteners in the future. These syrups produced by partial isomerisation of dextrose (corn sugar) into levulose are said to be comparable to sucrose (cane and beet sugar) in sweetening power and, unlike other corn syrups, can be used as complete substitutes for sucrose. An improved product and lower relative prices have made corn syrup a stronger competitor for sugar.

The substitution of corn syrup is a gradual process and the market reacts to long-run changes in prices. Substitution of corn syrups may require changes in manufacturing techniques and alter the quality of the final product. Firms making the substitution must invest in new techniques and develop promotional programs to "educate" the consumer to prefer the new product. Such difficulties mean that the food processor will shift from one source to another slowly and only when the processor can justify the change for a long period. In some instances, the level of use of corn syrup is restricted by the Food and Drug Administration. In other cases, corn syrup may not be an acceptable substitute, thus limiting the extent of substitutability.

A price war beginning in December of 1971 among the corn syrup producers dropped the equivalent cost ratio of corn syrup to sugar from 70 percent to 36 percent. Even now as corn syrup prices come up to 5.59 cents per pound in New York as of April, 1973, this is only 44 percent of the sugar equivalent in the Northeast (Table III-3).

Production of corn syrup is up and production facilities are fully utilized. A new entry into corn syrup production is Amstar, a cane sugar producer of "Domino" sugar and an owner of Spreckels beet sugar division.

Table III-3. Wholesale prices of sugar, corn syrup, and dextrose.

Year	Refined sugar Northeast	Dextrose N.Y.	Corn Syrup N.Y.	Dextrose relative to sugar	Corn syrup relative to sugar
	cents per pound, dry basis				
1956	8.77	7.91	8.90	90	101
1957	9.15	8.32	9.17	91	100
1958	9.27	8.33	9.18	90	99
1959	9.33	8.13	9.10	87	98
1960	9.43	8.13	9.12	86	97
1961	9.40	8.10	9.00	86	96
1962	9.60	8.04	8.73	84	91
1963	11.94	9.10	9.19	76	77
1964	10.68	8.85	8.36	83	78
1965	10.22	8.70	8.27	85	81
1966	10.36	8.87	8.34	86	81
1967	10.62	9.49	8.40	86	79
1968	10.84	9.49	7.85	86	72
1969	11.44	9.96	8.01	85	68
1970	11.97	10.20	8.45	85	71
1971	12.48	10.71	8.77	86	70
1972	13.09	10.07	5.78	77	44
1973 (April)	13.30	10.65	7.25	80	55

Source: Sugar Reports, USDA-ASCS, selected issues.

Demand and Price Elasticity

Estimates of price elasticity and cross elasticity demand for sugar in industrial uses do not exist. Price consciousness increases as the cost of sugar as a proportion of total food costs increases. The above development is evidence that substitution is occurring. The gradual adjustments indicate that demand is much more price-elastic in the long run as time of adjustment is increased.

Household use accounts for about one quarter of total consumption. Sugar is a minor item in the household budget and households tend not to make substitution for sugar when prices change. Estimates of price elasticity of demand for household use of sugar confirm this inelasticity with estimates ranging from -0.16 to -0.24 1/. Likewise, income has little influence with income elasticity estimates ranging from 0.03 to 0.15 1/. The corn syrup price cross elasticity is also small at 0.05 1/. Thus households will make little change in sugar consumption in response to changes in prices or incomes.

2. Government Sugar Policy 2/

The U.S. sugar industry has been protected and regulated by the Federal Government since 1789. A quota system of control was initiated in 1934 and has been amended and extended periodically since then. The current legislation governing the industry is the Sugar Act of 1948 as amended in 1971. This legislation became effective January 1, 1972, and extended the Act through December 31, 1974.

The principal provisions of the U.S. Sugar Act are (a) limitation of the total supply of sugar available to U.S. consumers, (b) Government subsidy payments to U.S. sugar cane and sugar beet growers, (c) an excise tax on all sugar marketed within the U.S., and (d) a tariff on sugar imports.

Under the supply limitation provision of the Sugar Act, the Secretary of Agriculture each year (a) determines the quantity of sugar needed to meet the requirements of domestic consumers and to attain the price objective specified in the Sugar Act, (b) divides, by means of quotas, this total supply requirement among specified domestic and foreign production areas, (c) assigns, when necessary for orderly production, "proportionate shares" of each domestic production area quota to individual farms within that

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1/ Thomas H. Bates and Andrew Schmitz, "A Spatial Equilibrium Analysis of the World Sugar Economy," Giannini Foundation Monograph No. 24, University of California, Berkeley, 1969, and P. S. George and G. A. King, "Consumer Demand for Food Commodities in the U.S. with Projections for 1980," Giannini Foundation, Monograph #26, Univ. of Calif., Berkeley, 1971.

2/ Adapted from "Initial Analysis of the Economic Impact of Water Pollution Control Costs upon the U.S. Cane Sugar Industry," Bruce J. Walter and Peter M. Emerson, ERS, USDA.

production area, and (d) imposes, when necessary for orderly marketing, a refined sugar "marketing allotment" upon each refining and importing firm. (See Table III-4 for the 1970, 1971, and 1972 quotas assigned to each domestic production area and foreign country.) Through these strong supply limitation powers granted by the Sugar Act, the Secretary of Agriculture is able to control the price of raw sugar.

The price objective specified in the Sugar Act is to maintain the same ratio between (a) the price of raw sugar, as registered in the New York market, and (b) the average of (i) the parity index (the index of prices paid by all farmers for commodities and services, including interest, taxes, and farm wages, 1967 = 100) and (ii) the wholesale price index (1967 = 100) as the ratio that existed during the period September 1, 1970, through August 31, 1971. The Secretary of Agriculture is required to make appropriate adjustments in his determination of national consumption requirements whenever the average price of raw sugar varies from the objective by 4 percent or more for 7 consecutive days (3 percent or more during November, December, January and February).

Sugar marketing is controlled under the provisions of the U.S. Sugar Act and numerous changes in the law since 1934 have permitted significant increases in the output of domestically-produced raw sugar. Even larger increases were granted to domestic refiners. Over time, the increases granted to each of the domestic sugar cane-production areas have been markedly different. This has affected the degree of modernization and the average size of the mills producing raw sugar in each area.

The Sugar Act provides for subsidy payments to U.S. sugar cane and sugar beet growers. These payments are made only to growers who meet the following conditions:

a. That the grower has not marketed cane or beets in excess of the proportionate share for the farm, as determined by the Secretary of Agriculture;

b. That no child labor (except family members) has been employed on the farm;

c. That all employed labor has been paid in full at not less than the minimum wage determined by the Secretary;

d. That growers who are also processors have paid other growers for purchased cane or beets at prices not less than those set by the Secretary.

Subsidy payments provide a powerful financial incentive for growers to observe the conditions imposed by the Sugar Act. If a grower fails to meet these conditions -- for example, attempts to market beets or cane in excess of his assigned proportionate share -- his payments are reduced

Table III-4. U.S. Sugar quotas: 1970, 1971 and 1972 basic and adjusted quotas by domestic production area and foreign country

Production area	1970		1971		1972	
	Basic Quota	Adjusted Quota 1/	Basic Quota	Adjusted Quota 1/	Basic Quota	Adjusted Quota 1/
	(short tons, raw value)		(short tons, raw value)		(short tons, raw value)	
Domestic						
Domestic beet	3,597,000	3,597,000	3,454,000	3,406,333	3,692,000	3,400,000
Mainland cane	1,308,000	1,308,000	1,256,000	1,256,000	1,643,000	1,643,000
Hawaii	1,145,486	1,145,486	1,110,000	1,110,000	1,218,238	1,218,238
Puerto Rico	1,140,000	360,000	1,140,000	150,000	855,000	175,000
Virgin Islands	15,000	--	15,000	--	--	--
Total domestic	7,205,486	6,410,486	6,975,000	5,922,333	7,408,238	6,436,238
Foreign						
Total Foreign	4,394,514	5,189,514	4,325,000	5,377,667	4,391,762	5,363,762
Grand Total	11,600,000	11,600,000	11,300,000	11,300,000	11,800,000	11,800,000

1/ Adjustments reflect (a) changes in total U.S. sugar requirements, (b) withheld quotas, and (c) deficits and deficit prorations.

Source: USDA-ASCS, Sugar Reports, No. 243 (August 1972), pp. 22-24.

or withheld entirely. Thus, subsidy payments are the principal legal device for obtaining compliance by domestic growers, just as import licenses are the means for obtaining compliance for foreign suppliers.

Conditional payments are made at the basic rate of 80 cents per 100 pounds of sugar recoverable from the cane or beets grown on farms producing less than 350 tons of sugar, raw value. The rate declines by stages to 30 cents per 100 pounds for all sugar in excess of 30,000 tons produced on a farm. In addition, growers may receive payments for abandoned acreage at the rate of one-third the normal yield for the farm; payments may also be received for crop deficiencies resulting from drought, flood, storm, freezing, disease, or insects which result in yields below 80 percent of normal. Generally, the payments for abandonment and deficiency are much smaller than the conditional payments made for sugar cane and sugar beets which are harvested and marketed. The 1970 and 1946-69 average return to sugar beet growers, including government payments, are presented in Table III-5 by production area and revenue source.

An excise tax is levied on sugar at the rate of 50 cents per 100 pounds, raw value. This tax is collected on all sugar marketed in the United States, regardless of source. Receipts from the tax in recent years have averaged more than $100 million per year, but payments to sugar cane and sugar beet growers have averaged about 15 percent less than the tax. Thus, the U.S. sugar program generates revenue which is deposited in the general funds of the U.S. treasury. However, it should be noted that the subsidy payments made under the Sugar Act and the sugar excise tax are legally separate. Thus, either one could be amended or repealed without affecting the other.

The equitable distribution of the benefits which the Sugar Act created was provided in addition to controlling the supply of sugar, imposing a tax on sugar sales and subsidizing sugar cane and sugar beet growers.

Imported sugar is at the same level of prices paid for domestically produced sugar. Sugar prices in the United States generally have been much higher than those prevailing in the world market (Table III-6). During the past two decades, world prices have exceeded the U.S. price only in 1950-51, 1957, 1963-64, and 1972. High U.S. sugar prices make this country a very desirable market for sugar exporting nations, especially those which do not have other preferred markets such as the United Kingdom or France. The value of the U.S. sugar market to an exporting nation is also affected by the importance of sugar exports to that nation's economy and the share of its sugar exports which can be sold in the United States. In addition to being the dominant factor in determining domestic sugar prices, the U.S. sugar program is, at times, also an important factor influencing world sugar prices. Each time that world sugar prices have risen sharply, U.S. prices have also risen, but more moderately. When world prices have increased, the Secretary of Agriculture has increased the U.S. sugar consumption requirement so as to make more sugar available to consumers here.

Table III-5. Sugar beet growers' returns per ton of sugar beets, United States, 1965-1970 average

	Basis of payment [1]	Processor payments for sugar beets produced [2]		Sugar act payments per ton of sugar beets produced		Total payments	
Crop Year	Net returns per cwt. sugar	per ton	Total	Sugar beets	Abandonment and deficiency	per ton	Total
	($)	($)	($1,000)	($)	($)	($)	($1,000)
1965	7.75	11.93	244,207	2.17	.11	14.21	290,933
1966	8.26	12.87	263,535	2.16	.37	15.10	309,071
1967	8.54	13.64	267,330	2.16	.08	15.88	311,199
1968	8.57	13.70	351,679	2.15	.06	15.91	408,444
1969	8.94	12.86	369,468	2.01	.09	14.96	429,835
1970	9.57	10.85	372,002	2.00	.06	16.99	430,157

[1] Net returns from beet sugar are gross returns minus excise tax, delivery and other marketing expenses as defined in the beet purchase contract. Excludes returns from by-products.

[2] Basic payment. Includes grower share is by-products where purchase contract provides for such sharing, but excludes allowances for hauling, pitting, siloing, etc.

Table III-6. Raw sugar prices in New York and the world market, 1948-72

Year	Raw sugar in New York	World sugar 1/	Difference: New York over world
	Cents per pound		
1948	5.54	5.13	0.41
1949	5.81	5.03	0.78
1950	5.93	5.82	0.11
1951	6.06	6.66	-0.60
1952	6.26	5.08	1.18
1953	6.29	4.27	2.02
1954	6.09	4.14	1.95
1955	5.95	4.19	1.76
1956	6.09	4.47	1.62
1957	6.24	6.10	0.14
1958	6.27	4.36	1.19
1959	6.24	3.86	2.38
1960	6.30	4.09	2.21
1961	6.30	3.85	2.45
1962	6.45	3.87	2.58
1963	8.18	9.41	-1.21
1964	6.90	6.79	0.11
1965	6.75	3.07	3.68
1966	6.99	2.81	4.18
1967	7.28	2.95	4.33
1968	7.52	2.96	4.56
1969	7.75	4.37	3.38
1970	8.07	4.88	3.19
1971	8.52	5.65	2.87
1972	9.09	8.53	0.56

1/ Adjusted to the New York delivery base.

Source: USDA-ASCS, Sugar Reports.

In 1950, the increase was from 7.5 million to 8.7 million tons; in 1957, from 8.8 million to 9.3 million tons; in 1963, from 9.8 million to 10.4 million tons; and in 1972, from 11.2 million to 11.8 million tons. In each case, the increased supply of sugar for U.S. consumers moderated the price rise here but, by decreasing supplies available for other importing countries, caused world prices to rise even further than expected. Since the United States is by far the world's largest importer of sugar -- taking 20 to 25 percent of the total in world trade -- unexpected changes in the volume of this country's imports have an appreciable effect on all other sugar importing and exporting countries.

Although U.S. sugar prices since the end of World War II have usually been maintained above the world market level, it does not follow that U.S. prices would have declined to the world level if quotas had not existed and import duties were unchanged. Without quotas, U.S. prices would have declined and those in the world market would have risen until they balanced at some intermediate level. No estimates of changes in U.S. and world prices, based on various assumptions regarding changes in quotas and tax policies, are available.

The U.S. sugar program has both benefited the domestic sugar industry and increased the average price paid by sugar users. The disadvantage to consumers of higher sugar prices has been partially offset by the benefit of extreme price stability relative to the prices of other agricultural products.

The Secretary of Agriculture also must adjust quotas for domestic areas. For example, should the effluent limitation guideline costs close plants in Michigan or Colorado and production is abandoned, the Secretary of Agriculture is required by law to distribute these acreages to other quota areas. The Secretary is directed to set quotas for the coming year such that the price objective for raw sugar as defined in the law is satisfied. If abandoned production were not reallocated, there would be a short run shortage of sugar forcing wholesale prices up, causing refiners to bid up the price of raw sugar, and thus causing divergence away from the price.

3. Base-Point Pricing

Base-point pricing developed because large refineries found it economical to locate close to ports of entry or adjacent to major population centers. This gave them ready access to off-shore sugar from which the bulk of refined cane sugar is manufactured. Because these refineries became the major sellers in their respective areas, they established base-point pricing. Eight points of origin are used in this base-point pricing. Within a region, the price at any point is the origin sugar price plus the freight cost from base point to the buyer's location. The principal seller in a region sets the price so as to maximize his profit in the region. All sellers of sugar compete to sell their excess sugar in the Chicago market. The Chicago market has been used because many food processors are located there and because the nation's rail system tends to come together at Chicago. The result of base-point pricing is lower prices in Chicago as can be seen in Table III-7. Obviously, the wholesale market for sugar is not one of perfect competition.

4. Supplies

Sugar imports play an important role in the U.S. supply with about 45 percent of the U.S. supply being imported as shown in Table III-4. Domestic cane sugar represented about 26 percent of the U.S. sugar supply in 1972. In recent years cane sugar supplies have been relatively constant.

B. Sale Prices

Reported sale prices for sugar and by-products are estimated from time to time by the U.S. Department of Agriculture, based on special industry cost studies carried out by USDA for use in their administration of the Sugar Act. The last detailed study covered the years 1966, 1967 and 1968. Estimates since that time are based on USDA and industry data sources. These sale prices (gross to the companies) are as follows:

Year	Beet Sugar	By-Products	
	($/cwt)	($/cwt sugar)	Percent
1966	10.21	1.15	11
1967	10.45	1.11	11
1968	10.56	1.03	10
1969	NA	NA	NA
1970	NA	NA	NA
1971	11.95^E	NA	10^E
1972	12.15^E	NA	10^E

These prices represent U.S. averages, with regional prices varying ±$.25 per hundredweight. These prices represent gross price received by the processors, from which he must cover his marketing, distribution and processing costs. This price should not be confused with the net proceeds price series sometimes reported. This series purports to be net of marketing and distribution costs paid by the processor. Also, it should be noted that under the basing-point pricing system, the processors must pay freight to the wholesale market. Most grower contracts specify that the growers' share of the proceeds is calculated after the deduction of marketing and distribution costs.

Table III-7. Wholesale prices for refined sugar, March 1973.

Location	100 lb. bag	bulk
	cents per lb.	
Northeast	13.31	12.70
Midcentral	12.85	12.25
Western Ohio-Lower Michigan	12.20	12.05
Southeast	12.95	12.45
Gulf	12.40	12.05
Chicago - West	11.75	11.55
Intermountain North	12.05	11.80
Pacific Coast	11.85	11.70

Source: Sugar Reports, USDA-ASCS, April 1973.

IV. ECONOMIC IMPACT ANALYSIS METHODOLOGY

The following economic impact analysis utilizes the basic industry information developed in Chapters I-III plus the pollution abatement technology and costs provided by Environmental Protection Agency. The impacts examined include:

Price effects
Financial effects
Production effects
Employment effects
Community effects
Other effects

Due to the crucial nature of potential plant shutdowns (financial and production effects) to the other impacts, a disproportionate amount of time will be devoted to the financial and plant closure analysis.

In general, the approach taken in the impact analysis is the same as that normally done for any feasibility capital budgeting study of new investments. In the simplest of terms, it is the problem of deciding whether a commitment of time or money to a project is worthwhile in terms of the expected benefits derived. This decision process is complicated by the fact that benefits will accrue over a period of time and that in practice the analyst is not sufficiently clairvoyant nor physically able to reflect all of the required information, which by definition must deal with projections of the future, in the cost and benefit analysis. In the face of imperfect and incomplete information and time constraints, the industry segments were reduced to money relationships insofar as possible and the key non-quantifiable factors were incorporated into the analytical thought process to modify the quantified data. The latter process is particularly important in view of the use of model plants in the financial analysis. In practice, actual plants will deviate from the model and these variances will be considered in interpreting financial results based on model plants.

A. Fundamental Methodology

Much of the underlying analysis regarding prices, financial and production effects is common to each kind of impact. Consequently, this case methodology is described here as a unit with the specific impact interpretations being discussed under the appropriate heading following this section.

The core analysis for this inquiry was based upon synthesizing physical and financial characteristics of the various industry segments through model or representative plants. The estimated cash flows for these model plants are summarized in Chapter II. The primary factors involved in assessing the financial and production impact of pollution control are profitability changes, which are a function of the cost of pollution control and the ability to pass along these costs in higher prices. Admittedly, in reality, closure decisions are seldom made on a set of well-defined common economic rules, but also include a wide range of personal values, external forces such as the ability to obtain financing or considering the production unit as an integrated part of a larger cost center where total costs must be considered.

Such circumstances often include but are not limited to the following factors:

1. There is a lack of knowledge on the part of the owner-operator concerning the actual financial condition of the operation due to faulty or inadequate accounting systems or procedures. This is especially likely to occur among small, independent operators who do not have effective cost accounting systems.
2. Plant and equipment may be old and fully depreciated and the owner may have no intention of replacing or modernizing them. He can continue in production as long as he can cover labor and materials costs and/or until the equipment deteriorates to an irrepairable and inoperative condition.
3. Opportunities for changes in the ownership structure of the plants (or firms) may exist through the acquisition of the plants by grower cooperatives where the principal incentive is that of maintaining sugar beet acreages in a situation where grower returns from sugar beet production are substantially above returns from alternative cropping opportunities. In this situation, which presently exists in the sugar beet industry, growers may elect to form producer-processor cooperatives and acquire ownership of processing plants which they would continue to operate at levels of return which would be unattractive to private owners.
4. Personal values and goals associated with business ownership may override or ameliorate rational economic rules; this complex of factors is commonly referred to as a value of psychic income.
5. The plant may be a part of a larger integrated entity and may either use raw materials being produced profitably in another of the firm's operating units wherein an assured market is critical or, alternatively, it may supply raw materials to another of the firm's operations wherein the source of supply is critical. When the profitability of the second operation offsets the losses in the first plant, the unprofitable operation may continue indefinitely because the total enterprise is profitable.

6. The owner-operator may believe that losses are temporary and that adverse conditions will dissipate in the future. His ability to absorb short-term losses will depend upon his access to funds, through credit or personal resources not presently utilized in this particular operation.

7. There may be very low (approaching zero) opportunity costs for the fixed assets and for the owner-operator's managerial skills and/or labor. As long as the operator can meet labor and materials costs, he will continue to operate. He may even operate with gross revenues below variable costs until he has exhausted his working capital and credit.

8. The value of the land on which the plant is located may be appreciating at a rate sufficient to offset short-term operating losses; and funds are available to meet operating needs. Opportunity costs of the owner-operator's managerial skills would be low.

The above factors, which may be at variance with common economic decision rules, are generally associated with proprietorships and closely-held enterprises rather than publicly-held corporations.

While the above factors are present in and relevant to business decisions, it is argued that common economic rules are sufficiently universal to provide a useful and reliable insight into potential business responses to new investment decisions, as represented by required investment in pollution control facilities. Thus, economic analysis will be used as the core analytical procedure. Given the pricing conditions, the impact on profitability (and possible closure) can be determined by simply computing the return on investment (or any other profitability measure) under conditions of the new price and incremental investment in pollution control. The primary consequence of profitability changes is the decision to close the plant rather than make the required investment to meet pollution control requirements.

In the most fundamental case, a plant will be closed when variable expenses (Vc) are greater than revenues (R), since by closing the plant, losses can be avoided. However, in practice, plants may continue to operate where apparently Vc > R. Reasons for this include:

. lack of cost accounting detail to determine when Vc > R.

. opportunity cost of labor or some other resource is less than market values. This would be particularly prevalent in proprietorships where the owner considers his labor as fixed.

. other personal and external financial factors.

. expectations that revenues will shortly increase to cover variable expenses.

A more probable situation is the case where $Vc < R$ but revenues are less than variable costs plus cash overhead expenses (TCc) which are fixed in the short run. In this situation a plant would likely continue to operate as contributions are being made toward covering a portion of these fixed cash overhead expenses. The firm cannot operate indefinitely under this condition, but the length of this period is uncertain. Basic to this strategy of continuing operations is the firm's expectation that revenues will increase to cover cash outlay. Factors involved in closure decisions include:

- extent of capital resources. If the owner has other business interests or debt sources that will supply capital input, the plant will continue.
- lack of cost accounting detail or procedures to know that $TCc > R$, particularly in a multiplant or multi business situation.
- labor or other resources may be considered fixed and the opportunity cost for these items is less than market value.

Identification of plants where $TCc > R$, but $Vc < R$ leads to an estimate of plants that should be closed over some period of time if revenues do not increase. However, the timing of such closures is difficult to predict.

The next level of analysis, where $TCc < R$, involves estimating the earnings before and after investment in pollution abatement. So long as $TCc < R$ it seems likely that investment in pollution control will be made and plant operations continued so long as the capitalized value of earnings (CV), the the firm's (industry) cost of capital, is greater than the scrap or salvage value (S) of the sunk plant investment. If $S > CV$, the firm could realize S in cash and reinvest and be financially better off. This presumes reinvesting at least at the firm's (industry) cost of capital.

Computation of CV involves discounting the future earnings flow to present worth through the general discounting function:

$$V = \sum_{n=1}^{t} A_n (1 + i)^{-n}$$

where

V = present value
A_n = a future value in n^{th} year
i = discount rate as target ROI rate
n = number of conversion products, i.e., 1 year, 2 years, etc.

It should be noted that a more common measure of rate of return is the book rate, which measures the after-tax profits as a ratio of invested capital, to net worth or sales. These ratios should not be viewed as a different estimate of profitability as opposed to DCF measures (discounted cash flow) but rather an entirely different profitability concept. The reader is cautioned not to directly compare the DCF rates with book rates. Although both measures will be reported in the analyses, the book rate is reported for informational purposes only.

Two primary types of DCF measures of profitability are used. One is called the internal rate of return or yield and is the computed discount rate (yield) which produces a zero present value of the cash flow. The yield is the highest rate of interest the investor could pay if all funds were borrowed and the loan were returned from cash proceeds of the investment. The second DCF measure is the net present value concept. Rathern than solve for the yield, a discount rate equivalent to the firm's cost of capital is used. Independent investments with net present values of above zero are accepted; those below zero are rejected. The concept of comparing capitalized earnings with the sunk investment value is a variation of the net present value method.

The data input requirements for book and DCF measures are derived, to a large extent, from the same basic information although the final inputs are handled differently for each.

1. Benefits

For purposes of this analysis, benefits for the book analysis have been called after-tax income and for the DCF analysis after-tax cash proceeds.

$$\text{After-tax income} = (1 - T) \times (R - E - I - D)$$

$$\text{After-tax cash proceeds} = (1 - T) \times (R - E - D) + D$$

where

T = tax rate

R = revenues

E = expenses other than depreciation and interest

I = interest expense

D = depreciation charges

Interest in the cash proceeds computation is omitted since it is reflected in the discount rate, which is the after-tax cost of capital, and will be described below. Depreciation is included in the DCF measure only in terms of its tax effect and is then added back so that a cash flow over time is obtained.

A tax rate of 48 percent was used throughout the analysis. Accelerated depreciation methods, investment credits, carry forward and carry back provisions were not used due to their complexity and special limitations. It is recognized that in some instances the effective tax rate may be lower in a single plant situation, but with the dominance of multiplant firms, the firm's tax rate will be close to the 48 percent rate.

Revenue, expenses, interest and depreciation charges used were those developed in Chapter II for the model plants and in Chapter V for pollution control facilities. These items were assumed to be constant over the period of analysis. Absolute levels may rise, but relative levels should remain constant.

2. Investment

Investment is normally thought of as outlays for fixed assets and working capital. However, in evaluating closure of an on-going plant where the basic investment is sunk, the value of that investment must be made in terms of its liquidation or salvage value, that is, its opportunity cost or shadow price.[1] For purposes of this analysis, sunk investment was taken as the sum of equipment salvage value plus land at current market values plus the value of the net working capital (current assets less current liabilities) tied up by the plant (see Chapter II for values). This same amount was taken as a negative investment in the terminal year.

The following impact analysis was based on total salvage value as defined above. The rationale for this was that the cash flows did not include any interest charges but rather brought interest charges into the analysis in the weighted cost of capital. This procedure required the use of total capital (salvage value) regardless of source. An alternative procedure would be to use as capital, net cash realization (total less debt retirement) upon liquidation of the plant. (In the single plant firm, debt retirement would be clearly defined. In the case of the multiplant firm, delineation of debt by plant would likely not be clear. Presumably this could be reflected in proportioning total debt to the individual plant on some plant parameter such as capacity or sales.) Under this latter procedure of using net realization, interest and debt retirement costs would have to be included in the cash flows and a discount rate reflecting only equity capital would have to be used rather than a weighted average cost of debt and equity capital.

The two procedures will yield similar results if the cost of capital and interest charges are estimated on a similar basis. The former procedure, total salvage value, was used as it gives reasonable answers and simplifies both computation and explanation of the cash flows and salvage values.

Annual reinvestment to maintain plant and equipment was taken as equal to annual depreciation, which corresponds to operating policies of some managements and serves as a good proxy for replacement in an on-going business.

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[1] This should not be confused with a simple buy-sell situation of a going concern which merely involves a transfer of ownership from one firm to another. In this instance, the opportunity cost (shadow price) of the investment would presumably be greater than the salvage value.

Investment in pollution control facilities was taken as the estimates provided by EPA and shown in Chapter V. Only incremental values were used, to reflect in-place facilities. Only the value of the involved land was taken as salvage value in the terminal year.

The above discussion refers primarily to the DCF analysis. Estimated book values were used for invested capital -- book value of fixed assets plus net working capital. In the case of new investment, its book value was estimated at 50 percent of the replacement cost.

3. Cost of Capital - After Tax

Return on invested capital is a fundamental notion in U.S. business. It provides both a measure of actual performance of a firm as well as expected performance. In this latter case, it is also called the cost of capital. The cost of capital is defined as the weighted average of the cost of each type of capital employed by the firm -- in general terms, equities and interest bearing liabilities. There is no methodology that yields the precise cost of capital, but it can be approximated within reasonable bounds.

The cost of equities may be estimated by two methods -- the dividend-yield method and the earnings-stock price (E/P ratio) method. Both are simplifications of the more complex DCF methodology. The dividend method is:

$$k = \frac{D}{P} + g$$

where

k = cost of capital
D = dividend yield
P = stock price
g = growth

and the E/P method is simply

$$K = E/P$$

where E = earnings
P = stock price

and is a further simplification of the first. The latter assumes future earnings as a level, perpetual stream.

The after-tax cost of debt capital was estimated by using an estimated 7.5 percent cost of debt and multiplying by .52 -- assuming a 48 percent tax rate. These values were weighted by the respective equity to total asset and total liabilities[1] to total asset ratios.

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[1] It is recognized that liabilities contain non-interest-bearing liabilities, but its weight is believed to be an adequate proxy for the weight of debt.

4. Construction of the Cash Flow

A twenty-two period cash flow was used in this analysis and was constructed as follows:

1. Sunk investment (salvage market value of fixed assets plus net working capital) taken in year t_o (1976).
2. After-tax cash proceeds taken for years t_1 to t_{20} (1977-1996).
3. Annual replacement investment, equal to annual current depreciation taken for years t_1 to t_{20}.
4. Terminal value equal to sunk investment taken in year t_{21} (1997).
5. Incremental pollution control investment taken in year t_o for 1977 standards and year t_6 (1982) for 1983 standards.
6. Incremental pollution expenses takne for years t_1 to t_{20} for 1977 standards and years t_7 to t_{20} for 1983 standards, if additive to the 1977 standards.
7. No replacement investment taken on incremental pollution investment on assumption of 20 years as provided by EPA.
8. Terminal value of pollution facilities equal to market land value taken in year t_{21} (1997).

B. Price Effects

At the outset, it must be recognized that price effects and production effects are intertwined with one effect having an impact upon the other. In fact, the very basis of price analysis is the premise that prices and supplies (production) are functionally related variables which are simultaneously resolved.

Solution of this requires knowledge of demand growth, price elasticities, supply elasticities, the degree to which regional markets exist, the degree of dominance experienced by large firms in the industry, market concentration exhibited by both the industry's suppliers of inputs and purchasers of outputs, organization and coordination within the industry, relationship of domestic output with the world market, existence and nature of complementary goods, cyclical trends in the indsutry, current utilization of capacity and, exogenous influences upon price determination (e.g., governmental regulation).

In view of the complexity and diversity of factors involved in determination of the market price, a purely quantitative approach to the problem of price effects is not feasible. Hence, the simultaneous considerations suggested above will be made. The judgement factor will be heavily employed in determining the supply response to a price change and alternative price changes to be employed.

As a guide to the analysis of price effects, the estimated price increase required to offset the effects of pollution control costs will be computed. The required price increase at the firm level will be evaluated in light of the relationship of the model plant to the industry and the understanding of the competitive position of the industry. The required price increase can be readily computed using the DCF analysis described above, but deals only with the incremental pollution investment and cash proceeds.

Application of the above DCF procedure to these costs will yield the present value of pollution control costs (i.e., investment plus operating cost less tax savings). If this is known, the price increase required to pay for pollution control can readily be calculated by the formula

$$X = \frac{(PVP)\ (100)}{(1T)(PVR)}$$

where:

X = required percentage increase in price
PVP = present value of pollution control costs
PVR = present value of gross revenue starting in the year pollution control is imposed

Note that this formula implies that incremental profits resulting from the price increase will be taxed at a rate of 48 percent.

C. Financial Effects

The financial characteristics of model plants presented in Chapter II will serve as the base point for the analysis of financial effects of pollution control. The primary focus of analysis will be upon profitability in the industry and the ability of the firms to secure external capital. Hence, it is obvious that this portion of the analysis cannot be divorced from production effects, since profit levels and the ability to finance pollution abatement facilities will have a direct influence on supply responses -- utilization of capacity and plant closures.

The measures of profitability analyzed will include the after-tax rate of return on the book value of invested capital and cash flow (after-tax profit plus depreciation). After-tax profit as a percent of sales will also be reported to assist in comparing financial data with standard industrial measures.

In addition to these factors, two additional measures of economic profitability will be examined: (1) capitalized value of earnings, and (2) present values estimated by the procedures described in Section A above. Both of these measures will be calculated on pre- and post-pollution control bases.

Given these financial measurements, the ability of the industry to finance the required pollution control expenditures will be reexamined in light of the financial results and the information shown in Chapter II. This ability will vary from one industry subsector to another due to differential financial structures, profitability and abatement requirements. Hence, capital availability and cost will probably have to be examined on a model plant-by-model plant basis.

D. Production Effects

Potential production effects include reductions of capacity utilization rates, plant closures and stagnation of industry growth. It is anticipated that reductions in capacity utilization will be estimated via qualitative techniques given the analysts; knowledge of the industry. The same is true for assessing the extent to which plant closures may be offset by increases in capacity utilization on the part of plants remaining in operation. Data limitations and time constraints require that the impact of pollution control standards upon future growth of the industry be estimated via qualitative methods.

The remaining effect, plant closures, is very difficult to estimate as discussed above in Section A. As a starting point in the plant closure analysis, the economic shutdown model will be employed to indicate which model plants might close. These conclusions will be based upon the decision rule that a plant will be closed when the net present value of the cash flow is less than zero.

It is recognized that the use of models to represent an industry is imperfect and that not all of the relevent values or factors can be included in the models. Hence, in this industry, the appropriate model plant results will be equated with each beet sugar plant and the variances to the model plant parameters will be subjectively evaluated to arrive at an estimate of the probability of closure. Three levels will be estimated -- high, medium and low.

The above analysis will be done under a without-pollution-control condition and a with-pollution-control condition. The former (including a consideration of historical trends) will establish a baseline against which total closures after pollution control will be compared, to arrive at an estimate of closures due to pollution control.

As discussed under fundamental methodology above, plants may continue to operate in face of more worthwhile uses of capital tied up by the plant. In such cases the plant, particularly single-or few-plant firms and closely-held firms would at least have to meet cash flow requirements, where cash flow is defined as sales less operating expenses, depreciation, interest, and taxes plus depreciation less debt amortization. Although the model plant data is not of sufficient quality for a plant-by-plant analysis, the plants judged to have the greatest likelihood of closure from the above DCF analysis will be examined on a cash flow basis.

E. Employment Effects

Given the production effects of estimated production curtailments, potential plant closings and changes in industry growth, a major consideration arises in the implications of these factors upon employment in the industry. The employment effects stemming from each of these production impacts will be estimated. To the extent possible, the major employee classifications involved will be examined as will the potential for re-employment.

F. Community Effects

The direct impacts of job losses upon a community are immediately apparent. However, in many cases, plant closures and cutbacks have a far greater impact than just the employment loss. Multiplier effects may result in even more unemployment. Badly needed taxes for vital community services may dwindle. Community pride and spirit may be dampened. However, in some cases, the negative community aspects of production effects may be very short-term in nature with the total impact barely visible from the viewpoint of the overall community. In a few cases, the closure of a plant may actually be viewed as a positive net community effect (e.g., a small plant with a high effluent load in an area with a labor shortage).

In the beet sugar industry, another serious community impact will be the effect on beet growers through losses of outlets, should plants close.

These impact factors will be qualitively analyzed as appropriate.

G. Other Effects

Other impacts such as direct balance of payments effects will alse be included in this analysis. This too will involve qualitative analyses.

V. POLLUTION CONTROL REQUIREMENTS AND COSTS

Water pollution control standards, technology and costs used in this analysis were provided by the Environmental Protection Agency. The contractor was asked in his Terms of Reference to review and comment upon this information and these comments are contained in the last section of this Chapter. Although several potentially important and significant cost-influencing factors are pointed out in the review, the basic cost estimates shown below and elsewhere are based upon the parameters provided by the Agency.

A. Alternative Effluent Control Levels

The general levels of pollution control in the beet sugar industry can be summarized[1] into four conditions as follows:

1. Alternative A - No waste treatment or control with effluent waste load of about 11.7 pounds BOD_5/ton beets processed (22 lbs. BOD_5/ton beets processed including Steffen wastes) for the selected typical plant at this minimal control level. Disposal of Steffen waste as dried pulp, by-product recovery or land disposal is assumed, as this is universally practiced in the industry. No control of lime mud slurry, flume water discharge, or condenser water flow is assumed.

2. Alternative B - Complete retention of lime cake slurry in earthen holding ponds (no discharge to receiving streams). The effluent waste load is estimated at 5.1 pounds BOD_5/ton beets processed (57 percent reduction of BOD_5 compared to Alternative A) for the selected typical plant at this control level.

3. Alternative C - Complete recycle of flume water with land disposal incorporating treatment of flume water by screening, settling, with mud drawoff to holding ponds for complete retention. The effluent waste load is estimated at 0.5 pounds BOD_5/ton beets processed (96 percent control) for the selected typical plant at this control level.[2]

4. Alternative D - Complete recycling of condenser water with excess condenser water disposal on land. Extensive water re-use within the factory process is assumed. The effluent waste load is estimated at zero pounds BOD_5/ ton beets processed (100 percent control) for the selected typical plant at this control level.

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[1] "Development Document for Effluent Limitations Guidelines and Standards of Performance for New Source Beet Sugar Processing," January, 1974, EPA, Washington, D.C.

[2] 0.5 lbs. BOD_5/ton of beets sliced equates to 2.2 kg/kkg of sugar processed.

Based on these alternatives, EPA has established the following effluent limitation guidelines for all beet sugar processing plants:

- Best Practical Control Technology Currently Available, July 1, 1977

  Maximum permissible discharge to surface waters of 0.5 pounds BOD_5 per daily ton of beets processed.

- Best Available Technology, July 1, 1983

  Maximum permissible discharge of 0.3 pounds BOD_5 per daily ton of beets processed for plants with (a) daily processing capacity of 2,300 tons or less and/or (b) daily soil filtration rate less than or equal to 1/16 inch; zero discharge for all other plants.

In the analysis which follows, four control alternatives were evaluated:

1. Maximum permissible discharge of 0.5 pounds BOD_5 for all plants in 1977; zero discharge for all plants in 1983.
2. Maximum permissible discharge of 0.5 pounds BOD_5 for all plants in 1977; 0.3 pounds BOD_5 per ton of beets processed for all plants with 2,300 tons or less of daily slicing capacity and/or a daily soil filtration rate of 1/16 inch or less in 1983; and zero discharge in 1983 for all other plants.
3. Zero discharge for plants with land available to build control facilities in 1977; zero discharge for all other plants in 1983.
4. Zero discharge for all plants in 1977.

B. Current Levels of Control

The beet sugar industry has historically used large quantities of water in processing beets. Where there was no recycling of water, water use amounted to:

	Maximum gal/ton beets sliced)
Flume water	4,000
Diffuse water	390
Lime mud	100
Condenser water	4,500
Miscellaneous	300
Total	9,200

In recent years, the sugar beet industry, through extensive programs of recyling and water use control, has succeeded in bringing total residual water in some instances down to as low as 200 gallons per ton of beets sliced. This is a remarkable achievement considering that each ton of beets being processed brings into the system 75 percent of total weight of 180 gallons of water in the new beet. Figure V-1 shows a flow diagram for a theoretical beet sugar factory water flow with complete water use and the potential sources of effluents from the processing system. The average plant, however, still is using over 2,000 gal of water per ton of beets sliced and thus huge quantities of water are involved.

With the extensive programs of water recycling, there has been an associated reduction in effluent discharges. The industry universally disposes of beet pulp, molasses and Steffen wastes through commercial by-product recovery or land disposal. Also, essentially all plants contain lime cake slurry in earthern holding ponds, with any associated blowdown restricted to percolation and/or evaporation.

Although not all of the 53 beet sugar plants operating during the 1972-73 campaign achieved a 0.5 pound BOD_5 per ton of sliced beets (96%) level of control, the industry, on the average, exceeded this level. The current level of pollution abatement in the beet sugar industry can be described on a plant-by-plant basis by the degree of flume and condenser water recycling or municipal hookup as follows:

1. No flume or condenser water recycling where the effluent waste load is about 3.0 pounds BOD_5 per ton.

2. Flume water recycling only where the effluent waste load is about 0.5 pounds BOD_5 per ton from condenser water discharge.

3. Flume and condenser water recycling with blowdown disposal into surface waters where the effluent waste load is about 0.5 (or less) pounds BOD_5 per ton.

4. Flume and condenser water recycling with blowdown disposal on land. This procedure yields a zero discharge level into surface waters.

5. Disposal of blowdown into municipal sewer systems.

The plants in each of the categories are enumerated below in Table V-1. Five of the six plants without any water recycling are located in Michigan. The only other such plant is located in Nebraska. These plants, representing seven percent of the daily slicing capacity are the smaller and older units. The average capacity is 2,250 tons of daily slicing capacity. The 20 plants with flume recycling only are predominately located in the Red River Valley and the Western Plains. Their average slicing capacity is about 3,300 tons which compares to the industry average of 3,600 tons and they compose 35 percent of daily slicing capacity. These plants tend to be slightly newer than those without recycle facilities. Ten plants presently have flume and condenser recycling with discharge to surface waters. Their average size is 3,750 tons. These ten plants have 20 percent of the daily industry slicing capacity. Presently 11 plants report zero discharge. These plants are large (average daily slicing capacity of 4,950 tons) and tend to be the

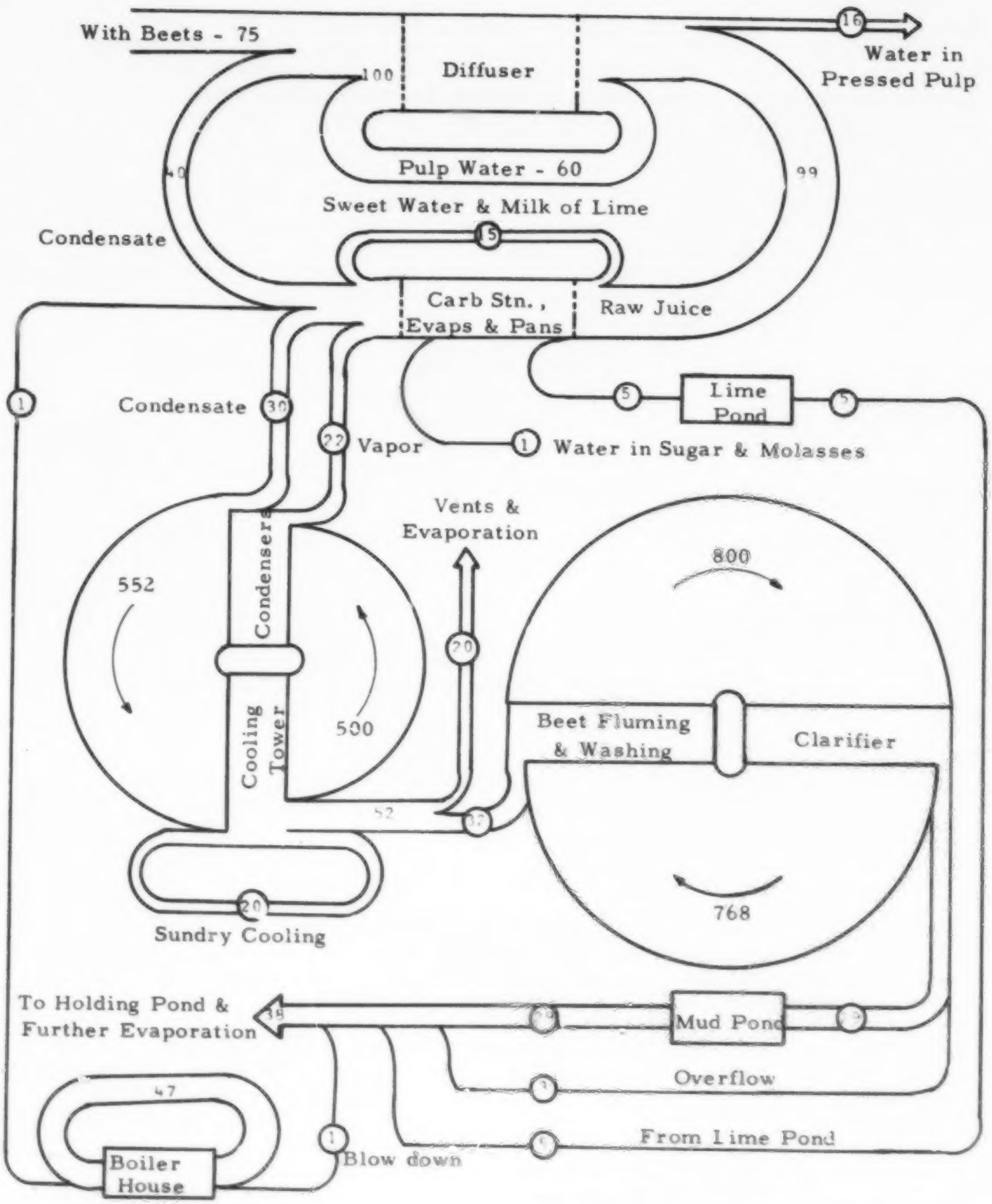
With Beets - 75
100
Diffuser
16
Water in Pressed Pulp
Pulp Water - 60
40
99
Sweet Water & Milk of Lime
15
Condensate
Carb Stn., Evaps & Pans
Raw Juice
1
Condensate
30
22
Vapor
5
Lime Pond
5
1
Water in Sugar & Molasses
Vents & Evaporation
552
Condensers
Cooling Tower
500
20
800
Beet Fluming & Washing
Clarifier
52
32
20
Sundry Cooling
768
To Holding Pond & Further Evaporation
38
Mud Pond
Overflow
47
Boiler House
1
Blow down
From Lime Pond

Figure V-1. Theoretical beet sugar factory water flow with complete water reuse.

Note: All figures are percent on beets.

Table V-1. Current status of water pollution control in beet sugar industry

Status	Plant Location		Date built (year)	Size (TPD)	Campaign (days)
	Town	Region			
1. No recycling					
	Caro	I	1890	1,900	145
	Bay City	I	1901	4,000	145
	Carrolton	I	1902	2,000	145
	Croswell	I	1902	1,400	145
	Sebewaing	I	1902	2,000	145
	Mitchell	III	1920	2,240	114
Total	6	-	-	13,540	-
2. Flume recycle					
	Crookston	II	1954	3,900	176
	Rocky Ford	III	1900	3,024	100
	Greeley	III	1902	2,180	100
	Sterling	III	1905	2,440	114
	Fort Morgan	III	1906	3,445	124
	Scotts Bluff	III	1910	3,300	125
	Gering	III	1916	2,215	124
	Bayard	III	1917	2,285	117
	Ovid	III	1926	2,760	119
	Torrington	III	1926	3,034	110
	Garland	IV	1903	2,550	180
	Billings	IV	1906	4,280	166
	Lovell	IV	1916	2,235	165
	Worland	IV	1917	1,900	145
	Twin Falls	IV	1916	4,600	115
	Mini Cassia	IV	1917	6,725	110
	Delta	IV	1920	1,500	80
	Toppenish	IV	1937	4,050	185
	Nyssa	IV	1938	6,575	125
	Clarksburg	V	1935	3,100	142
Total	20	-	-	65,898	-

Table V-1 (continued)

Status	Plant Location		Date built	Size	Campaign
	Town	Region	(year)	(TPD)	(days)
3. Flume and condenser recycle and discharge	East Grand Forks	II	1926	2,750	164
	Moorehead	II	1948	3,900	182
	Drayton	II	1965	5,000	161
	Loveland	III	1901	3,670	110
	Eaton	III	1902	2,145	100
	Longmont	III	1903	3,190	107
	Brighton	III	1917	2,190	100
	Idaho Falls	IV	1903	4,200	170
	Sidney	IV	1925	4,000	140
	Brawley	V	1947	6,500	105
Total	10	-	-	37,545	-
4. Zero discharge					
	Hereford	III	1964	6,493	85
	Goodland	III	1968	3,400	129
	Moses Lake	IV	1953	10,500	185
	Betterovia	V	1897	4,800	200
	Spreckles	V	1899	5,500	200
	Hamilton City	V	1906	2,500	145
	Tracy	V	1917	4,500	236
	Montega	V	1917	4,500	200
	Woodland	V	1937	3,300	200
	Mendota	V	1963	4,400	200
	Chandler	V	1966	4,500	200
Total	11	-	-	54,393	-
5. Municipal hookup	Fremont	I	1900	3,050	157
	Finlay	I	1911	1,535	153
	Ottawa	I	1912	1,700	150
	Nampa	IV	1942	9,050	120
	Santa Anna	V	1912	1,851	125
Total	5	-	-	17,186	-
Grand Total	52	-	-	188,562	-

Source: Development Planning and Research Associates, Inc.

Note: Region I - Michigan and Ohio
Region II - Minnesota - North Dakota
Region III - Western Plains
Region IV - Montana
Region V - California - Arizona

newer plants. These plants are located in low rainfall areas, with seven of the eleven in California and Arizona. Excepting the Nampa, Idaho plant, the plants on municipal hookups are small relative to industry average. Three are located in Michigan - Ohio, one in Montana and one in California. Only nine percent of the industry capacity is on municipal hookups.

As shown in Table V-1, nearly 30 percent of the industry presently are achieving zero discharges to surface waters. Based on the technical considerations shown above relating recycling to waste load, another 55 percent of the beet sugar industries' daily slicing capacity is at the 0.5 (or less) pounds BOD_5 per ton beets sliced level. Thus, excepting the Great Lakes geographic segment, the focus of the zero discharge standard will be on obtaining the last four percent of pollution abatement in terms of BOD.

C. Water Pollution Abatement Costs

Water Pollution abatement costs used in this study were based on cost data performance parameters and estimating equations provided by the Environmental Protection Agency 1/. The Contractor in some cases had to estimate pollution control cost data where EPA data were insufficient to match certain plant situations.

1. Investment

Investment for lime slurry ponds was estimated as:

$$I_L = (1.75 \times 10^{-5}) \frac{CL}{S} C_1$$

where

I_L = Investment in lime slurry pond

C = Capacity in tons of beets sliced per day

L = Length of campaign in days

S = Seepage or percolation of water from the pond in inches per day

C_1 = Cost of land plus cost of construction per acre.

1/ "Development Document for Effluent Limitations Guidelines and Standards of Performance for New Sources, Beet Sugar Processing," January, 1974, EPA and correspondence.

The constant, 1.75, is a function of the conversion factors of the amount of water and mud blowdown to the pond, conversion of gallons of water to acre feet and acre inches together with the time factor of days per year and the maximum depth to which ponding will occur.

Two options for flume recycling investment were provided. Option C-1 was based upon a mechanical clarifier with a flume water recirculation system. Option C-2 was based upon an earthen pond clarifier with a flume recirculation system. The investment estimating equations for each are as follows:

$$I_{FC-1} = K_1 + (5.26 \times 10^{-5}) \frac{CL}{S} C_1$$

$$I_{FC-2} = K_2 + (5.26 \times 10^{-5}) \frac{CL}{S} C_1$$

where

I_{FC-1} = Investment in option C-1 flume recycle system

I_{FC-1} = Investment in option C-2 flume recycle system

K = Equipment investment

C = Capacity in tons of beets sliced per day

L = Campaign length in days

S = Seepage rate in inches per day

C_1 = Cost of land and pond construction cost per acre

Investment in equipment for each option is made up as follows:

	Option C-1	Option C-2
Flume water screen	$ 16,000	$16,000
Clarifier	89,000	--
Piping Changes	51,000	51,000
Pumps (3 @ $2,200)	6,600	6,600
Motors (3 @ $1,000)	3,000	3,000
Mud Panel	--	7,000
Total Equipment Cost	$165,600	$83,600

The constant, 5.26, is similar to the lime slurry pond constant except it takes into account a blowdown (20%) of the flume water.

Three investment options were provided for condenser recycle equipment and ponds. Option D-1 was based on a cooling tower, D-2 on a cooling pond and D-3 on a spray pond. The estimating equations were as follows:

$$I_{CD-1} = K_3 + 56C + (2.02 \times 10^{-5}) \frac{CL}{S} C_1$$

$$I_{CD-2} = K_3 + (8.34 \times 10^{-3}) + (2.02 \times 10^{-5}) \frac{CL}{S} C_1$$

$$I_{CD-3} = K_3 + 52C + (2.02 \times 10^{-5}) \frac{CL}{S} C_1$$

where

I_{CD-1} = Investment Option D-1

I_{CD-2} = Investment for Option D-2

I_{CD-3} = Investment for Option D-3

K_3 = Condenser system recycle equipment

C = Capacity in tons of beets sliced per day

L = Campaign length in days

S = Seepage in inches per day

C_1 = Cost of land and pond construction

In Option D-1, the 56C estimates the cost of a cooling tower as a function of plant capacity in tons per day. In D-2, the (8.34×10^{-3}) estimates the size in acres of a cooling pond. In D-3, the 52C estimates the cost of spray pond as a function of plant capacity.

Condenser recycle equipment included the following:

Piping changes	$51,000
Pumps (3 @ $2,200)	6,600
Motors (3 @ $1,000)	3,000
Total	$60,600

All basic land and pond cost estimates were based upon an assumed average of $1,000 per acre land purchase price and $2,000 per acre pond construction costs. Land requirements were computed on the basis of one-quarter inch seepage per day. As will be discussed subsequently in this report, significant variances to these values are likely to occur in some locations. These variances in land costs are discussed on page V-22 and were taken into consideration in the final analysis of plant closures.

The above equipment and pond construction costs are purportedly on a 1971 basis. These estimates were adjusted to a 1972 basis by use of the sewage treatment plant construction cost index provided by EPA. With 1957-59, equal to 100, the index in 1971 was 159.83 and 171.98 in 1972. Thus, the 1971 estimates were expanded by 1.076 to obtain a 1972 level.

2. Operating and Ownership Costs

Annual operating and maintenance costs, excluding interest and depreciation, were estimated by EPA to be 10 percent of equipment and pond construction (excluding land costs) investment. Additionally, a constant annual expense of $15,000 for dredging the flume water pond was used.

Annual depreciation charges of five percent were taken on equipment and pond construction investment. This presumes a twenty-year life and no salvage value.

3. Estimated Costs

Based upon the data and equations described above, cost estimates were developed for model plants representative of the various segments and pollution status currently found in the industry. Because some segments of the industry have made significant progress toward zero discharge levels, it was necessary to develop incremental control costs to reflect already in-place pollution abatement facilities.

Using the data presented in Table V-1, plants were grouped into three plant sizes and classified by campaign length and recirculation status as shown in Table V-2. This distribution of the 36 plants not yet at zero discharge or on municipal hookups served as a basis for formulating costs for the model plant analysis. For purposes of the subsequent impact analysis, it was assumed that all plants had lime slurry ponds in place and that these costs were reflected in the base case. Thus, the incremental costs for pollution abatement included combination flume and/or condenser recycling and containment as appropriate.

The added abatement facilities configurations associated with the alternative standards being evaluated were as follows:

Table V-2. Summary of beet sugar plants by size, campaign length analysis and recirculation status

Campaign (days)	Small (< 2,300 TPD) Recirculation status			Medium (2,300-3,900 TPD) Recirculation status			Large (> 3,900 TPD) Recirculation status		
	All	Flume	None	All	Flume	None	All	Flume	None
105	0	0	0	0	0	0	1	0	0
110	2	3	1	0	0	0	0	0	0
115	0	0	0	2	6	0	0	0	0
130	0	3	0	0	0	0	0	0	0
145	0	0	4	0	1	1	2	5	0
160	0	0	0	0	0	0	1	0	0
175	0	0	0	2	2	0	0	0	0
Total	2	6	5	4	9	1	4	5	0

Alternative	Added Facilities Configuration
Plants without recycle facilities	
To 0.5 pounds BOD_5 per ton processed	Flume pond, mechanical clarifier, piping, pumps and motors
From 0.5 to 0.3 pounds	Improved operation of 0.5 level
From 0.5 pounds to zero	Additional ponding, cooling tower, piping, pumps and motors
Directly to zero discharge	All of the above
Plants with flume recycle only	
To zero discharge	Ponding, cooling tower, condenser, piping, pumps and motors
Plants with flume and condenser recycling	
To zero discharge	Ponding only

In the model plant analysis, plants with flume recirculation only were assumed to have flume ponds and equipment currently in place. Plants with flume and condenser recirculation were assumed to have flume ponds and associated equipment and condenser piping, pumps, motors and cooling towers in place. It is recognized that actual plants may have a portion of the ponding in place or not have cooling towers in place, which would alter the incremental costs for these plants. However, these configurations are believed to reasonably approximate the various industry conditions.

The estimated in-place and incremental investment and annual costs for the four basic types of pollution conditions (excepting zero discharge and municipal hookups) used in the model plant analysis are shown in Tables V-3 to V-5.

The costs reported in Tables V-3 through V-5 do not include incremental costs for moving from the 0.5 to 0.3 pounds of BOD_5 per ton of beets processed for plants with a daily capacity of less than 2,300 tons of beets and/or a soil filtration rate of 1/16 inch or less per day. Theoretically, this improvement can be met at approximately the same treatment costs required for achieving the 0.5 level. Reportedly, many of the plants operating at the 0.5 level are actually achieving results equal to the 0.3 level. Therefore, in the impact analysis, no incremental costs will be used for

Table V-3. Estimated current and incremental costs for pollution control in beet sugar model plants without recycling

			Incremental cost to reach .5 level 1/						Incremental cost to reach zero level from .5 level				Incremental cost to reach zero level from current level					
			Investment		Annual Costs				Investment		Annual Costs		Investment		Annual Costs			
Plant size (TPD)	Campaign (days)	Seepage (in/day)	Land	Cons. and equip.	Dredging	O&M	Total	Depreciation	Land	Cons. and equip.	O&M	Depreciation	Land	Cons. and equip.	Dredging	O&M	Total	Depreciation
					$1,000													
1750	110	1/4	41	265	15	26	41	13	16	204	20	10	57	469	15	47	62	24
1750	145	1/4	59	304	15	30	45	15	21	215	22	11	80	519	15	52	67	26
2800	145	1/4	85	361	15	36	51	18	33	305	30	15	118	666	15	67	82	34

1/ No incremental costs for those plants required to reach 0.3 level for the 0.5 level. See discussion on pages V-12 and V-16.

Table V-4. Estimated in-place and incremental costs for pollution control on beet sugar model plants with flume recycling only and discharges

			In-place					Incremental Cost to Reach Zero			
			Investment		Annual Costs			Investment		Annual Costs	
Plant size (TPD)	Campaign (days)	Seepage (In./day)	Land	Construction & equipment	Dredging	O & M	Depreciation	Land	Construction & equipment	O & M	Depreciation
			$1,000								
1,750	110	1/4	41	265	15	27	13	16	204	20	10
1,750	130	1/4	47	279	15	28	14	19	210	21	10
1,750	145	1/4	59	304	15	30	15	21	215	22	11
2.800	115	1/4	68	325	15	32	16	26	290	29	14
2,800	145	1/4	85	361	15	36	18	33	305	30	15
2,800	175	1/4	106	406	15	41	20	40	319	32	16
5,000	105	1/4	110	415	15	42	21	44	460	46	23
5,000	145	1/4	153	507	15	51	24	59	493	49	24
5,000	160	1/4	169	542	15	54	25	65	505	50	25

Table V-5. Estimated in-place and incremental costs for pollution control on beet sugar model plants with flume and condenser recycling and discharges

			In-place					Incremenatal cost to reach zero level			
			Investment		Annual costs			Investment		Annual costs	
Plant size	Campaign	Seepage	Land	Construction & equipment	Dredging	O & M	Depreciation	Land	Pond construction	O & M	Depreciation
(TPD)	(days)	(in./day)	$1,000								
1,750	110	1/4	41	436	15	44	22	16	33	3	2
1,750	130	1/4	47	450	15	45	23	19	40	4	2
1,750	145	1/4	59	475	15	48	24	21	44	4	2
2,800	115	1/4	68	558	15	56	28	26	56	6	3
2,800	145	1/4	85	595	15	60	30	33	71	7	4
2,800	175	1/4	106	640	15	64	32	40	80	8	4
5,000	105	1/4	110	781	15	78	39	44	94	9	5
5,000	145	1/4	153	874	15	87	44	59	127	13	6
5,000	160	1/4	169	908	15	91	45	65	139	14	7

going from the 0.5 to the 0.3 level. It should be noted that there may be exceptions to this assumption for a specific plant; however, the incremental costs would be insignificant in comparison to the costs of moving from no treatment to the 0.5 level or from 0.5 (or 0.3) to zero discharge. Thus, the basic conclusions of the closure analysis would not be affected.

In the following model plant, financial analysis investment was assumed to occur in 1976 or 1982 as appropriate with annual costs beginning in the following year. The salvage value for in-place facilities was limited to the value only for both the current shadow priced investment and the terminal value of assets-- assumed to be in year 21.

D. Land Availability Formula

In determining the land availability condition of a beet sugar factory in order to meet zero discharge in 1977, a definition was established by EPA. A plant was said to "have land available" if the sums of the net acreages for lime, flume and condenser ponds as determined by EPA formulae shown below, plus allowance for plant site and beet storage, were less than the total owned acreage contiguous to each beet sugar factory. Plants were said to "not have land available" if the needed net acreages for lime, flume and condenser water ponds plus plant site and beet storage acreages were greater than the total owned acreages contiguous to the beet sugar factory.

The land requirements were computed as follows:

$$\text{Plant and beet storage acreage} = 29.5 - .0055C + (.3749 \times 10^{-6})\,C^2$$
per 1,000 tons

$$\text{Lime Pond Acreage} = 1.75 \times 10^{-5}\ \frac{CL}{S}$$

$$\text{Flume Water Pond Acreage} = 5.26 \times 10^{-5}\ \frac{CL}{S}$$

$$\text{Condenser Water Acreage} = 2.02 \times 10^{-5}\ \frac{CL}{S}$$

where

C = Capacity in tons beets sliced per day

L = Length of campaign in days

S = Seepage in inches of water per day.

The plant and beet storage equation was estimated by DPRA from aerial photographs of eight beet sugar factories of various sizes and locations. After establishing a scale of measurement for each photograph, the plant area itself and the beet storage area were scaled and set forth in Table V-6.

Each of the pond constants -- 1.75, 5.26 and 2.02 -- are EPA-calculated constraints that convert the various units of the above formulae to common denominator of days, feet, inches, gallons and areas and also take into account the water blowdown per ton of beets sliced for each type of effluent as well as the depth of ponding.

The calculated acres needed for ponds by the above formulae for each beet sugar plant is shown in Table V-7.

E. Comments on Cost Data

The Terms of Reference, under which this report was prepared, asked for review and comment on the cost data and parameters provided by EPA for use in the impact analysis. Comments are made below on seepage and land values.

1. Seepage or Percolation Rates

Inasmuch as the technology and costs of water treatment provided by EPA use seepage of impounded water as a means of water disposal, seepage rates become important. Water in unsealed earthern ponds seeps from the bottom of the pond and percolates through the subsoil at various rates depending on the soil and its condition. Generally, the standard of 1/4 inch seepage per day chosen by EPA is practical for most soils in the United States, but in some cases this rate may be inappropriate.

Some states (a complete list was not available) limit seepage at a rate less than 1/4 inch per day. Also, some areas have soils where the seepage capacity is less than 1/4 inch per day.

Two areas of significance to the beet sugar industry are the "thumb" area of Eastern Michigan and the Red River Valley on the Minnesota-North Dakota border. Here the soil type, precipitation amount, severity of winter and lack of evaporation all contribute to a very low seepage or percolation rate.

For Michigan, Dr. Earl Erickson [1], a soil physicist at Michigan State University, reports that in the clay-loam to loam soil of the "thumb" district, clear water may have a percolation rate of 0.02 inches per hour

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[1] Personal communication.

Table V-6. Selected plant sites and storage acreages from aerial photographs

Plant Location	Total Acres	Plant Site and Storage Acres	Capacity (TPD)	Plant Site and Storage Acres per 1,000 TPD Beets Sliced
E. Grand Forks	550	40	2,750	14.6
Crookston	493	72	3,700	19.5
Moorehead	386	80	3,900	20.5
Bay City	90	55	4,000	13.7
Twin Falls	237	44	4,600	9.5
Drayton	800	80	5,000	16.0
Mini Cassia	211	50	6,725	7.5
Nyssa	219	61	9,050	6.7

Table V-7. Land availability by EPA formula (continued)

Region and Plant Location	Date Started	Capacity 1/ (TPD)	Campaign (days)	Seepage Rate (in/day)	EPA Formula Acres	Plant Site Acres	Total Acres Required	Owned Acres	Land Avail-able	Zero Now
Region III (con't.)										
Brighton	1917	2,190	100	1/4	84	42	126	122	--	--
Bayard	1917	2,285	117	1/4	102	43	145	428	X	--
Mitchell	1920	2,240	114	1/4	98	43	141	402	X	--
Ovid	1926	2,760	119	1/4	126	46	172	127	--	--
Torrington	1926	3,034	110	1/4	233	49	282	200	--	--
Hereford	1964	6,493	85	1/4	--	--	--	1,000	--	X
Goodland	1968	3,400	129	1/4	--	--	--	740	--	X
Region IV										
Idaho Falls	1903	4,200	170	1/4	273	55	328	200	--	--
Garland	1903	2,550	180	1/4	176	45	221	80	--	--
Billings	1906	4,280	166	1/4	273	55	328	164	--	--
Twin Falls	1916	4,600	115	1/4	203	44	245	237	--	--
Lovel	1916	2,235	165	1/4	141	42	183	246	X	--
Worland	1917	1,900	145	1/4	106	39	145	200	X	--
Mini Cassia	1917	6,725	110	1/4	283	50	333	211	--	--
Delta	1920	1,500	80	1/4	46	36	82	100	X	--
Sidney	1925	4,000	140	1/4	215	54	269	250	--	--
Toppenish	1937	4,050	185	1/4	287	54	341	200	--	--
Nyssa	1938	6,575	125	1/4	315	61	376	219	--	--
Nampa	1942	9,050	120	1/4	--	--	--	375	--	X
Moses Lake	1953	10,500	185	1/4	--	--	--	1,000	--	X

continued.....

Table V-7. Land availability by EPA formula

Region and Plant Location	Date Started	Capacity 1/ (TPD)	Campaign (days)	Seepage Rate (in/day)	EPA Formula Acres	Plant Site Acres	Total Acres Required	Owned Acres	Land Avail-able	Zero Now
Region I										
Caro	1890	1,900	145	1/16	424	38	462	100	--	--
Freemont	1900	3,350	157	1/16	--	--	--	60	--	X
Bay City	1901	4,000	145	1/16	888	55	943	90	--	--
Carrollton	1902	2,000	145	1/16	444	40	484	130	--	--
Croswell	1902	1,400	145	1/16	308	34	342	80	--	--
Sebewaing	1902	2,000	145	1/16	444	40	484	150	--	--
Findlay	1911	1,535	153	1/16	--	--	--	82	--	X
Ottawa	1912	1,700	150	1/16	--	--	--	100	--	X
Region II										
Mason City	1917	2,300	(73-closed)	1/16	--	--	--	--	--	--
E. Grand Forks	1926	2,750	164	1/16	692	40	738	550	--	--
Moorehead	1948	3,900	182	1/16	1,088	80	1,168	386	--	--
Crookston	1954	3,700	176	1/16	1,000	72	1,072	493	--	--
Drayton	1965	5,000	161	1/16	1,232	80	1,312	800	--	--
Region III										
Rockyford	1900	3,024	100	1/4	116	54	170	523	X	--
Loveland	1901	3,670	110	1/4	155	49	204	134	--	--
Eaton	1902	2,145	100	1/4	82	41	123	62	--	--
Greeley	1902	2,180	100	1/4	84	41	124	74	--	--
Longmont	1903	3,190	107	1/4	257	50	307	248	--	--
Sterling	1905	2,440	114	1/4	107	43	150	327	X	--
Ft. Morgan	1906	3,445	124	1/4	164	51	215	249	X	--
Scottsbluff	1910	3,300	125	1/4	158	52	210	467	X	--
Gering	1916	2,215	124	1/4	105	42	147	230	X	--

continued.....

Table V-7. Land availability by EPA formula (continued)

Region and Plant Location	Date Started	Capacity[1/] (TPD)	Campaign (days)	Seepage Rate (in/day)	EPA Formula Acres	Plant Site Acres	Total Acres Required	Owned Acres	Land Avail-able	Zero Now
Region V										
Bettoravia	1897	4,800	200	1/4	--	--	--	--	--	X
Spreckels	1899	5,500	200	1/4	--	--	--	--	--	X
Hamilton City	1906	2,500	145	1/4	--	--	--	--	--	X
Santa Anna	1912	1,851	175	1/4	--	--	--	--	--	X
Tracy	1917	4,500	236	1/4	--	--	--	--	--	X
Monteca	1917	4,500	200	1/4	--	--	--	--	--	X
Clarksburg	1935	3,100	200	1/4	238	50	280	175	--	--
Woodland	1937	3,300	200	1/4	--	--	--	--	--	X
Brawley	1947	6,500	105	0	262	58	320	640	X	--
Mendota	1963	4,400	200	1/4	--	--	--	--	--	X
Candler	1966	4,500	200	1/4	--	--	--	--	--	X

[1/] Capacities developed from contacts with each beet sugar firm.

in clay loam. He also states that the addition of 0.5 percent solids would reduce, through organic matter, percolation to a trace within one year. The tight soil condition of Eastern Michigan, where the beet plants are located, is in direct contrast to the high percolation sandy soils of Western Michigan, where waste water irrigation systems are being used.

In the northern part of the Red River Valley, North Dakota State has found the infiltration rate of beet sugar processing effluent through storage lagoons on the Fargo silty clay to be very low. For instance one column of soil allowed passage of only 433 ml in 7 1/2 days and another only 83 ml 2/.

These figures represent about 0.066 and 0.013 inches per day, respectively. There was no evidence from these experiments that the effluents were causing any soil clogging as compared to distilled water.

Contacts with Soil Conservation Service offices at Denver, Lincoln and Fort Collins confirm the tight soil characteristics of the Red River Valley and Michigan as compared to the other three regions of beet sugar plant locations.

A reduction of the seepage rate from one-fourth inch to one-sixteenth inch would increase the required pond area by four times and increase investment and costs in almost the same proportion. The reduced seepage rate due to soil characteristics was recognized and reflected in the following impact analysis.

2. Land Values

Land values of beet plant sites and adjacent land range from valuation as rural farm land to valuation as prime industrial property. Reported land values on beet plants run from a low of $500 per acre to a high of $6,000 per acre, based on the Contractor's survey of the industry.

For purposes of financial analysis, present and incremental pollution control costs, $1,000 per acre suggested by EPA was used. However, in evaluating the potential management decision for individual plant operation or closure, the estimated land value was considered. Land values were reported to average $2,300 per acre on a national basis, but vary from region to region as shown below:

2/ "Disposal of Sugar Refining Lagoon Effluents on Fargo Silty Clay Soil," Dr. B. R. Funke and Fred W. Schroer, North Dakota State University Experiment Station Bulletin.

	Min. Price ($ acre)	Max. Price ($ acre)	Ave. Price ($ acre)	No. of Estimates
Region 1	2,000	3,000	2,250	4
Region 2	900	2,500	1,350	4
Region 3	500	6,000	2,500	14
Region 4	600	4,000	1,520	10
Region 5	3,000	3,000	3,000	1
Total	--	--	2,300	29

These land cost variables for individual plants have been incorporated into the impact analysis, as shown in Table VI-6.

VI. IMPACT ANALYSIS

The impacts considered in this analysis include the following:

A. Price effects
B. Financial effects
C. Production effects
D. Employment effects
E. Community effects
F. Balance of payment effects

A comprehensive and detailed impact analysis of each of the above was beyond the scope of this study. Consequently, efforts were allocated more to financial and plant analyses, with lesser detail allocated to macro-impacts.

A. Price Effects

Estimated price increases necessary for the industry to maintain its current levels of profitability are not large, although certain segments will require much higher price increases than others. Table VI-1 shows the estimated price increases required to maintain estimated current profitability levels, based on the model plant analyses. As shown, excepting the plants with no water recirculation, the required price increase ranges from 0.2 to 0.8 percent.

Considering that nearly 30 percent of the industry's present daily slicing capacity (in terms of production this will be equivalent to about 40 to 45 percent of the annual production due to the longer campaign of these plants) is already in compliance with the zero discharge level and another 20 percent of the industry's daily slicing capacity (representing about 30 percent of the production) requires only a 0.2 percent increase, one can conclude that the price increase due to pollution control would be minimal. This situation also suggests the possibility that required price increases may not be passed forward.

Since the demand for sugar at the household level is relatively inelastic, we doubt such a price increase would alter these consumption patterns significantly. Although price elasticities for industrial uses and cross elasticities with other sweetners, such as cane sugar, corn sweetners and synthetics, are not known with certainty, there appears to be a possibility that beet sugar will become less competitive, although in the final analysis, it will depend on the impact of pollution control costs on the U.S. domestic cane sugar industry. The situation is further compounded by the role of sugar imports, which represent about 45 percent of total sugar consumption.

Table VI-1. Estimated price increases to maintain profitability and meet zero discharge levels

	Small (1750 TPD)			Medium (2800 TPD)			Large (5000 TPD)		
	Recirculation			Recirculation			Recirculation		
Campaign	All	Flume	None	All	Flume	None	All	Flume	None
(days)	----------	----------	----------	----------	Percent	----------	----------	----------	----------
105							.2		
110	.2	.8	2.2						
115				.2	.7	1.5			
130		.7							
145			1.8		.6		.2	.5	
160							.2		
175				.2	.5				

Beet sugar's ultimate competitive position under present legislation will depend upon the Department of Agriculture's policy regarding the levels of import quotas. The objectives of the Sugar Act, discussed in Chapter III, suggest that pollution control costs could receive some consideration.

The Act, in Section 205 entitled "Allotments of Quotas or Prorations," states that the Secretary (Agriculture) shall make allotments to assure an orderly and adequate flow of sugar, prevent disorderly market or importation, to maintain a continuous and stable supply of sugar, and to afford all interested persons an equitable opportunity to market sugar. It seems that under this Section the Secretary could make adjustments in quotas to allow for increased costs due to pollution controls. However, in so doing, it is likely that the Secretary would take into account the cost impacts of pollution control on both the beet and cane sugar industries. The Secretary would be constrained to variances in the price objective of some 3 to 4 percent, defined in Section 202 of the Act.

Thus, an important factor in price changes in response to imposition of pollution controls appears to be the position which the Secretary chooses to take. It is of interest to note that some members of the beet sugar industry believe the Secretary is not presently taking full advantage of his powers to insure their welfare. Of further interest is the fact that some professionals who are involved or have studied the United States sugar policy suggest that the benefits of a domestic sugar industry are considerably less than the cost of maintaining this industry and suggest that our policy be redirected in favor of increased imports. Given the current posture toward removal of the overnment agricultural controls, it seems that a ruling by the Secretary in favor of increased prices for the domestic sugar industry can not be automatically expected.

Satisfaction of one purpose could be interpreted to be in conflict with another. In view of current pressures to keep food prices down, the provision of ample sugar supplies at reasonable prices might well receive greater weight than the other purposes. However, this reflects the opinion of DPRA only.

It is doubtful that any significant price increases can be achieved by the beet sugar industry to offset new non-productive pollution control investment. Much of the industry, in terms of capacity, is at or near zero discharge level; furthermore, two-thirds of the sugar moves into industrial markets which appear to be price conscious. Also, the indirect government price controls may be a barrier to price increases. However, it is DPRA's opinion that any price adjustments that might include incremental cost of pollution control will be most likely made in terms of the total domestic sugar industry; that is, the cane and beet sugar taken together. Looking at the beet sugar segment alone, it is concluded that under existing competitive price structures, the large firms not requiring significant price increases will probably tend to hold the line on prices. However, if the cane sugar industry as a whole is found to ultimately require a 2 or 3 percent price increase, adjustments may be made to protect the domestic industry by reducing import quotas and price increases of this magnitude may be passed along. If this were to happen, the small impacted beet producers could experience some relief.

Processors may be able to share the costs with growers, either through lower beet prices or through grower cooperatives taking over the processing. However, this appears doubtful due to the already in-place control facilities of a large portion of the industry. Also, in the case of the grower cooperatives, the member-patrons have personally incurred significant debt obligations as well as check-off obligations on future beet deliveries. Thus, it seems unlikely that growers will opt for lower beet prices, although this will depend on profitability and risk levels for other crops in each of the producing areas.

A further complicating factor concerning price increases is the fact that beet growers receive a share of the proceeds from beet sugar sales, either based on measured sugar content of the harvested beet -- peculiar to the West -- or based on actual sugar yield -- peculiar to the East. For this reason, the total price increase may need to be slightly larger on a percentage basis to allow the firms to recover pollution control costs.

B. Financial Effects

Measurement of the financial effects of water pollution control on the beet sugar industry requires knowledge of the existing financial condition of the industry to serve as a baseline plus projections of the key financial indicators following pollution control implementation. These estimates were based on the model plants described in Chapter II and the incremental costs by model plants discussed above in Chapter V.

1. Profitability

As shown in Chapter II, the beet sugar industry is not highly profitable, with after-tax returns on invested capital of two to five percent. Thus, any investment increase without a profit increase will only compound this situation.

Profitability effects for purposes of this analysis are measured on both a book rate of return and discounted cash flow procedure. In line with the conclusions of the previous section, no price increases were taken in this analysis.

As shown in Table VI-2, the book rate of return, after imposition of zero discharge, is reduced; but, the magnitude of the change declines as one moves from plants with no recycling to plants with flume and condenser recycling in place. This would be expected as the incremental costs to meet

Table VI-2. Estimated book rate of return and cash flows before and after zero discharge standards

Status and Plant Configuration	Campaign (days)	After-tax ROI Base	After-tax ROI Zero discharge	Cash Flow Base	Cash Flow Zero discharge
		---- pct --------		---- $1,000 ------	
No recycling					
1750	110	.9	-.5	156	125
1750	145	4.6	2.8	293	269
2800	145	8.7	5.7	655	629
Flume recycling only					
1750	110	.1	-.5	150	125
1750	130	2.0	1.6	218	212
2800	115	3.6	3.1	409	401
2800	145	6.9	5.7	636	628
2800	175	9.7	7.4	862	853
5000	145	5.2	4.8	1,269	1,265
Flume and condenser recycling					
1750	110	-.4	-.5	128	126
2800	115	3.2	3.1	403	401
2800	175	9.2	9.1	856	843
5000	105	-.2	-.3	672	663
5000	145	4.9	4.8	1,260	1,256
5000	160	6.5	6.3	1,481	1,477

zero discharges decline moving from no in-place recirculation to circulation in place. The ROI for the plants with no recycling is reduced by about 1.5 to 3.0 percentage points, reflecting both a decline in after-tax income and higher invested capital. The small plants move from a small positive return to a small negative return.

In the case of flume recycling only, the impact of meeting a zero discharge level is a 0.5 to 2.3 percentage point reduction in ROI. Here too the small, short campaign plant is shown to move from a small positive to a small negative ROI. Where flume and condenser recycling is in place, the decline in ROI is only 0.1 percentage point reflecting the very small incremental cost (increased ponding only) necessary to meet a zero discharge.

The impact on cash flow (after tax income plus depreciation) shows similar trends (Table VI-2), although the impact is much less pronounced. It should be noted that no additional interest charges were assumed for new pollution control investment in the results shown in Table VI-2. It is conceivable that additional interest charges may be incurred and,if so, the impact of the zero discharge standard would be slightly higher than indicated.

The above book rate of return analysis, although indicative, has a number of weaknesses relating to timing of investment, depreciation policies and the artificiality of book value as an estimate of invested capital. Because of these weaknesses, another measure -- present value of discounted cash flow -- was computed. This method is believed to be superior and more indicative of impacts.

Present values were computed at a 7.5 percent discount rate which is the approximate after-tax cost of capital (equity and debt) in the beet sugar industry. (The computation of this is discussed in Chapter V.) A higher rate would make these impacts more severe and a lower rate would reduce the impacts. (Cost of capital rates and associated present values are shown in the next section.) The impact of pollution controls on present values is significant. As shown in Table VI-3, the plants requiring both flume and condenser recycling facilities have significantly reduced capitalized earnings, ranging up to a 66 percent reduction for the small, short-season plants. The plants requiring condenser recycling only are less impacted, ranging from a five to 34 percent reduction in capitalized earnings. Plants with existing flume and condenser recycling are impacted least in financial terms, generally a two to three percent reduction in capitalized earnings, excepting the very small plants and/or short campaigns of 110 days or less.

Another view of these data can be obtained from comparing the capitalized earnings with the sunk investment or subtracting capitalized earnings from the sunk investment. If capitalized earnings are less than the sunk investment value (or if the present value is less than zero), the firm would be better off to realize the sunk investment in cash by closing the plant and reinvesting these proceeds where they could yield the cost of capital rate. Looking at these data from this viewpoint, it can be seen that Model numbers 1, 4, 5, 10 and 13 have sunk investment valued higher than capitalized earnings under present conditions (see Table VI-4 for 6.0 percent).

Table VI-3. Estimated present values of cash flows for model beet sugar plants without and with pollution control (computed at 7.5 percent)

			Current		Reduction in capitalized cash flow due to pollution control			
					.5 lbs. BOD - 1977 and zero in 1983		Zero discharge	
Model No.	Size and status	Campaign	Sunk investment[1]	Capitalized earnings	Dollars	Percent	Dollars	Percent
		(days)	($1,000)	($1,000)	($1,000)		($1,000)	
No recycling								
1	1,750	110	1,870	1,094	626	57	727	66
2	1,750	145	2,280	2,581	695	27	805	31
3	2,800	145	3,480	6,004	866	14	1,023	17
Flume recycling only								
4	1,750	110	1,910	807	-	-	277	34
5	1,750	130	2,150	1,645	-	-	285	17
6	2,800	115	3,000	3,238	-	-	392	12
7	2,800	145	3,560	5,654	-	-	413	7
8	2,800	175	4,150	8,066	-	-	442	5
9	5,000	145	6,530	8,764	-	-	682	7
Flume and condenser recycling								
10	1,750	110	1,910	675	-	-	55	8
11	2,800	115	3,000	3,044	-	-	96	3
12	2,800	175	4,150	7,883	-	-	131	2
13	5,000	105	5,180	2,312	-	-	148	6
14	5,000	145	6,530	8,468	-	-	199	2
15	5,000	160	7,050	10,824	-	-	213	2

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[1] Sunk investment value at shadow-price (scrap for equipment, market value for land and working capital).

Table VI-4. Net present values for model plants under alternative conditions of pollution control

Status and plant configuration	Campaign	Model No.	6.0 percent cost of capital	7.5 percent cost of capital	Closure probability
	(days)	$1,000			
No recycling					
1,750 TPD	110	1			
No controls			-560	-776	H
0.5 lbs BOD-1977 or 0.3 lbs BOD-1983			-1,032	-1,230	H
0.5 lbs BOD-1977 } 0 - 1983			-1,220	-1,402	H
0 - 1977			-1,310	-1,503	H
1,750 TPD	145	2			
No controls			721	301	L
0.5 lbs BOD-1977 or 0.3 lbs BOD-1983			191	-212	M
0.5 lbs BOD-1977 } 0 - 1983			-7	-394	H
0 - 1977			-107	-504	H
2,800 TPD	145	3			
No controls			3,425	2,524	L
0.5 lbs BOD-1977 or 0.3 lbs BOD-1983			2,798	1,914	L
0.5 lbs BOD-1977 } 0 - 1983			2,519	1,658	L
0 - 1977			2,377	1,501	L
Flume recycling only					
1,750 TPD -	110	4			
No controls 1/			-920	-1,103	H
Zero			-1,204	-1,380	H
1,750 TPD	130	5			
No controls 1/			-207	-505	H
Zero			-499	-790	H
2,800 TPD	115	6			
No controls 1/			772	238	L
Zero			372	-154	M
2,800 TPD	145	7			
No controls 1/			2,955	2,094	L
Zero			2,535	1,681	L

Continued . . .

Table VI-4 (Continued)

Status and plant configuration	Campaign	Model No.	6.0 percent cost of capital	7.5 percent cost of capital	Closure probability
	(days)	----------------	$1,000	----------------	
Flume recycling only					
2,800 TPD	175	8			
No controls 1/			5,106	3,916	L
Zero			4,656	3,474	L
5,000 TPD	145	9			
No controls 1/			3,611	2,234	L
Zero			2,915	1,552	L
Flume and condenser recycling					
1,750 TPD	110	10			
No controls 1/			-1,069	-1,235	H
Zero			-1,124	-1,290	H
2,800 TPD	115	11			
No controls 1/			554	144	L
Zero			457	- 52	M
2,800 TPD	175	12			
No controls 1/			4,898	3,733	L
Zero			4,767	3,602	L
5,000 TPD	105	13			
No controls 1/			-2,359	-2,868	H
Zero			-2,507	-3,016	H
5,000 TPD	145	14			
No controls 1/			3,278	1,938	L
Zero			3,083	1,739	L
5,000 TPD	160	15			
No controls 1/			5,432	3,774	L
Zero			5,223	3,561	L

Note: H = High
M = Medium
L = Low

1/ Same net present values apply to the second condition of 0.5 pounds BOD_5 by 1977 and 0.3 pounds BOD_5 by 1983. Plants with flume recycling and with flume and condenser recycling in-place already meet the 0.5 pounds BOD_5 standard and would have no significant change in NPV in going to 0.3 BOD_5 standard.

Imposition of pollution controls add Model numbers 2, 6 and 11 to this list. In short, imposition of pollution controls reduces the earning value of the impacted model plants from two to 60 percent, depending on the present condition, plant size and campaign length. From these data, it is clear that plants requiring additional investment will have significant profit impacts. This is particularly true of those plants not yet recirculating water and to a lesser extent for those with flume recirculation only. Also the plants with short campaign seasons appear to be impacted more severely than the plants with longer campaigns.

In placing the model plant results in perspective, it would appear that the Michigan and Colorado segments would be most impacted, due to the existence of smaller plants, shorter campaigns, and/or no in-place recirculation. In terms of companies, Great Western, Michigan Sugar and Moniter would appear to be particularly hard hit relative to other firms, due to the number of impacted plants each owns. This is contrasted to Utah-Idaho and Amalgamated, who have larger and more modern plants.

2. Capital Availability

As discussed in Chapter II, the beet sugar industry as a whole appears to be hard pressed to attract new capital. Imposition of new capital requirements, particularly for non-productive assets, would appear to impact Great Western and the Michigan companies particularly hard. Great Western is in the midst of negotiations for purchase by a grower cooperative. Growers apparently have pledged both cash and check-off against future production for equity financing of the purchase. Immediate cash requirements by farmers have apparently been met in many cases through mortgages on their farm business and an additional capital requirement could be serious, since the availability of funds from this group is no doubt finite.

This becomes particularly noticeable when looking at the proforma cash flows, which are quite small for the small and short campaign plants. These are the older, more depreciated plants. Considering existing debt and the new requirements for pollution control, one would speculate that debt servicing could be a difficult problem for companies with plants of this type. Although the ability to meet debt service charges is important, the low rates of return suggest that attraction of debt or risk capital will be difficult for the less profitable segments of the industry.

C. Production Effects

Of critical and fundamental interest is the production impact which pollution control may cause. Of particular interest are potential plant closures. As discussed in Chapter IV, the methodology used was to apply a shutdown model to representative plants and to compare the appropriate model plant results with each of the firms in the beet sugar industry and draw inferences for each based on its relationship to the model.

1. Potential Plant Closures

Net present values, computed at 6.0 and 7.5 percent after-tax cost of capital, for each of the model conditions are shown in Table VI-4. In interpreting this table, values less than zero indicate that the firm would be financially better off to liquidate the sunk investment and reinvest where that money could yield the industry's target return.

Inspection of these values indicate that the larger and/or longer campaign plants are sound operations, but that owners of the smaller and/or short campaign plants would appear to be financially improved by closing. Table VI-4 also shows that plants with no recycling are impacted much more severely than those with flume and condenser recirculation in place. This, of course, would be expected since the incremental costs (as shown in Chapter V) are quite large for plants with no recycling in place.

As previously indicated, the model plant results must be interpreted in light of the actual key parameters in the industry since they cannot all be reflected in the model plant analysis. The factors listed in Table VI-5 show the key parameters evaluated and the relationship of the model plants to the industry.

None of the 52 operating plants fit the models precisely, especially in regard to capacity. Three model sizes of 1,750, 2,800 and 5,000 TPD represent a range of plant sizes from 1,400 TPD to 10,500 TPD, a 7 1/2 fold spread. The financial models show that larger plants tend to be more profitable, so that in each model range those larger than the model should be more profitable and the smaller ones less profitable. As with size, age bears a direct relationship; older plants are smaller and less able to withstand cost impacts than are the newer, usually larger plants.

Model plants have minimum land areas in their structure. When considering water pollution control, land availability is a prime consideration for ponds and lagoons. Plants without land are forced to make land purchases. The model shows $1,000 per acre as an average price but a survey of plants places average land prices at $2,300 per acre. Thus, the availability of land improves on the model's performance while lack of land proves to be a serious deficiency.

The length of campaign made significant differences in model plant performance. A number of model campaigns from 105 to 175 days were run. Plants that can improve on those model numbers will better their performance through the lowered fixed costs per unit that longer campaigns can deliver. Conversely shortened campaigns diminish performance.

Just as in the case of land availability, those plants that have land and are currently closer to zero discharge in level of pollution technology have a better chance of operating successfully. The lower the degree of water pollution control in place, the more money is yet to be spent to achieve zero discharge. Conversely, the greater the degree of pollution control in place, the better the performance.

Table VI-5. Parameters used in evaluating actual plants against model plant results

Factors	Model Plants	Industry Plants
1. Type of plant	Straight	Straight and Steffen House
2. Capacity TPD	3 plants 1,750-2,800-5,000 TPD	52 plants 1,400 to 10,500 TPD
3. Campaign	9 campaigns 110 to 175 days	27 compaigns 80 to 236 days
4. Age	Small - 50 years Medium - 40 years Large - 20 years	4 to 83 years
5. Ownership	Corporate Multi-plant	Corporate and Co-op Single and multi-plant
6. Land owned	Purchased for each pond configuration	60 to 1,700 acres
7. Land availability	Available	Available to not available in varying degrees
8. Land value	$1,000 per acre	$600 to $6,000 per acre
9. Seepage	1/4" per day	1" to trace per day
10. Evaporation	None	29" to 63" per year
11. Precipitation	None	12" to 28" per year
12. Winter season	Constant	Mild to severe
13. Continuity of beets	Continuing supply	Continuing to diminishing supply
14. Consolidation	Not considered	Possible
15. Potential for municipal hook-up	Not considered	Some potential to no potential

continued.....

Table VI-5. Parameters used in evaluating actual plants against model plant results (continued)

Factors	Model Plants	Industry Plants
16. In-place pollution control facilities	Lime pond No recycle Flume recycle Flume and condenser recycle	Lime pond No recycle Partial flume recycle Complete flume recycle Partial condenser recycle Complete condenser recycle Zero discharge Municipal hook-up
17. Technology	Close flume loop Close condenser loop Seepage ponds Dredging	Close flume loop Close condenser loop Seepage ponds Evaporation ponds Irrigation Dredging Solid waste disposal

All model plants were assumed to have 1/4 inch per day seepage. Some plants can exceed this rate but in the case of seepage this may not indicate improved performance. Seepage may need to be controlled or reduced to avoid contamination or to comply with state regulations. Lesser seepage does suggest poor performance related to the model as lower seepage means more land, more cost and a greater impact for shutdown.

The models assumed a continuing supply of beets. It is apparent then that any plant in an area without continuity of beet supply, whether it be due to encroaching urbanization or other reasons, has severe future problems.

The model does not consider the possibility of discharging the beet sugar effluent into a municipal sewage system. However, if such an opportunity exists (and only two have been noted), this would be a strong positive factor.

Finally, plants that are seriously impacted by any of the above factors will be considered more likely candidates for closure if the plant is near a larger, newer plant that may have possibilities of expansion.

All of these factors were evaluated in forming judgments about the extent of impact on each plant and the resultant expected response to additional control standards.

Table VI-6 is the compilation of factors that form the basis of the composite judgment regarding the probability of closure -- a high, maybe or low.

By following through the 22 information bits on one plant, the analyst can make his own analysis of the economic impact of pollution control and a personal judgment of management's probable response to this impact.

As an example, consider the Scottsbluff plant in Region III. By following across the columns, the factors of this plant show the following:

1.	Capacity - 500 TPD larger than 2,800 ton model	+
2.	Built in 1910 - 63 years old - 40 years old model	-
3.	125 day campaign - longer than 115 day model	+
4.	Municipal hook-up possibility - none - same as model	0
5.	Zero Discharge now - none - same as model	0
6.	No Recycle - N.A. - same as model	0
7.	Flume Recycle - yes - same as model	0
8.	Condenser recycle - no - same as model	0
9.	Condenser Cool - no - same as model	0
10.	Pond acres calculated - same as model	0
11.	Plant site acres - calculated same as model	0
12.	Total acres - calculated same as model	0
13.	Owned acres 467 - exceeds model greatly	+
14.	Land availability - yes	+
15.	Land cost - not applicable	0

Table VI-6. Factors used in beet sugar plant closure analysis

				Current status							Calculated needs			Land									Model plant financial analysis			
Plant Location	Capacity (TPD)	Date built	Campaign (days)	Municipal sewage	Zero now	Type plant	No recycle	Recycle Flume	Recycle Condenser	Condenser cool	Ponds (acres)	Plant (acres)	Total (acres)	Owned (acres)	Available	Cost ($ per A)	Owner	Seepage rate (in/day)	Evaporation-precipitation (inches)	Severity of winter	Consolidation possibilities	Beet continuity	Base	.5 lb. BOD 1977	Zero discharge 1977	Model no.
Region I																										
Caro	*1,900	1899	145			N 3/	X				106	38	144	100		2,000	Mich.	1/16	30-28	Severe	X	X	L	H	H	2
Fremont	3,050	1900	157	X		N	-				-	-	-	60		-	G-W	-	30-28	Mod		X	-	-	-	-
Bay City	4,000-	1901	145			N	X				222	55	277	90		3,000	Monitor	1/16	30-28	Severe		X	L	L	L	3
Carrollton	2,000	1902	145			N	X				111	40	151	110		NA	Mich.	1/16	30-28	Severe	X	X	L	H	H	2
Croswell	-1,400	1902	145			N	X				77	34	111	80		2,000	Mich.	1/16	30-28	Severe	X	X	L	H	H	2
Sebewaing	2,000	1902	145			N	X				111	40	151	150		2,000	Mich.	1/16	30-28	Severe	X	X	L	H	H	2
Findlay	-1,535	1911	153	X		N	-				-	-	-	82		-	G-W	-	30-28	Mod		X	-	-	-	-
Ottawa	-1,700	1912	150	X		N	-				-	-	-	100		-	Buckeye	-	30-28	Mod		X	-	-	-	-
Region II																										
Mason City (closed)																										
E. Grand Forks	2,750	1926	164			N		X	X		173	40	213	550	1/	2,500	Co-op	1/16	29-20	Severe	X	X	L		L	12
Moorhead	3,900-	1948	182			N		X	X	X	272	80	352	386	1/	1,000	Co-op	1/16	29-20	Severe		X	L		L	12
Crookston	3,700-	1954	176			N		X			253	[illegible]	322	493	1/	900	Co-op	1/16	29-20	Severe	X	X	L		L	8
Drayton	5,000-	1965	161			N		X	X	X	308	80	386	800	1/	1,000	Co-op	1/16	29-20	Severe		X	L		L	15
Region III																										
Rocky Ford	3,024	1900	100			S		X			116	54	170	525	X	2,000	Co-op	1/4	56-14	Mod		X	L		M	6
Loveland	3,670-	1901	110			S		X	X	X	155	49	204	134		6,000	G-W	1/4	56-14	Mod	X		L		M	11
Eaton	2,145	1902	100			N		X	X	X	82	41	123	62		3,000	G-W	1/4	54-14	Mod	X	X	H		H	10
Greeley	2,100	1902	100			N		X			84	41	125	76		3,000	G-W	1/4	54-14	Mod	X		H		H	4
Longmont	3,190	1903	107			S		X	X	X	257	50	307	248		4,000	G-W	1/4	54-14	Mod	X		L		M	11
Sterling	2,440	1905	114			N		X			107	43	150	327	X	1,500	G-W	1/4	54-14	Mod		X	L		M	6
Fort Morgan	3,445	1906	124			S		X			164	51	215	249	X	1,500	G-W	1/4	54-14	Mod		X	L		M	6
Scottsbluff	3,300	1910	125			S		X			158	52	210	467	X	4,000	G-W	1/4	54-14	Mod	X	X	L		M	6
Gering	2,215	1916	124			S		X			105	42	147	230	X	2,000	G-W	1/4	53-14	Mod	X	X	H		H	5
Lyman	2,190	1917	100			N		X	X	X	84	42	126	122		4,000	G-W	1/4	53-14	Mod	X		H		H	10
Bayard	2,265	1917	117			N		X			102	43	145	428	X	1,000	G-W	1/4	53-14	Mod	X	X	L		M	6
Mitchell	2,243	1920	114			N	X				98	43	141	402	X	1,500	G-W	1/4	53-14	Mod	X	X	H	*	H	1
Ovid	2,760	1926	119			N		X			126	46	172	127		1,000	G-W	1/4	53-14	Mod		X	L		M	6
Torrington	3,036	1926	110			S		X			233	49	282	200		500	Holly	1/4	53-14	Mod		X	L		M	6
Hereford	6,493-	1964	85		X	N																				
Goodland	3,400	1968	129		X	N																				
Region IV																										
Idaho Falls	4,200-	1903	170			S		X	X	X	273	55	328	200		1,000	U-I	1/4	41-12	Severe		X	L		L	15
Garland	2,550-	1903	180			S		X			176	45	221	80		2,000	U-I	1/4	41-12	Severe		X	L		L	8
Billings	4,280-	1906	166	2/		S		X			273	55	328	164		4,000	G-W	1/4	41-12	Severe		X	L		L	9
Twin Falls	4,600-	1916	115	2/		S		X		X	201	44	245	237		1,000	Amal	1/4	41-12	Severe		X	L		L	9
Lovell	2,235	1916	165			N		X			141	42	183	246	X	1,000	G-W	1/4	41-12	Severe		X	H		H	5
Worland	-1,900	1917	145			S		X			106	39	145	260	X	600	Holly	1/4	41-12	Severe		X	H		H	5
Mini Cassia	6,725-	1917	110			N		X		X	283	50	333	211		1,000	Amal	1/4	41-12	Severe		X	L		L	9
Delta	-1,500	1940	80			S		X		X	46	36	82	100	X	1,000	Holly	1/4	41-12	Severe		X	H		H	4
Sidney	4,000-	1925	140			N		X	X	X	215	54	269	250		600	Holly	1/4	41-12	Severe	X	X	L		L	14
Toppenish	4,050-	1937	185			N		X		X	287	54	341	200		3,050	U-I	1/4	41-12	Mod		X	L		L	9
Nyssa	6,575-	1938	125			S		X			315	61	376	219		3,000	Amal	1/4	41-12	Mod		X	L		L	9
Nampa	9,050-	1942	120	X		N																				
Moses Lake	10,500-	1953	185		X	S																				
Region V																										
Betteravia	4,800-	1897	200		X	N																				
Spreckles	5,500-	1899	200		X	S																				
Hamilton City	2,500	1906	145		X	N																				
Santa Ana	-4,851	1912	175	X		S																				
Tracy	4,500-	1917	236		X	S																				
Manteca	4,500-	1917	200		X	N																				
Clarksburg	3,100	1935	142			N		X			238	50	288	175		3,000	Co-op	1/4	63-8	Mild		X	L		L	7
Woodland	3,360	1937	200		X	S																				
Brawley	6,500-	1947	105			N		X	X	X	262	58	320	640	X		Holly	0	63-8	Mild		X	H		H	13
Mendota	4,400-	1963	200		X	S																				
Chandler	4,500-	1966	200		X	N																				
Totals				5	11		6	25	10	13					16											

1/ Assumed 1/16 seepage therefore land not available.

2/ Possibility of hookup to municipal sewage exists.

3/ N = Straight
S = Steffen

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16.	Ownership - currently corporate - soon to be coop	+
17.	Seepage 1/4" per day - same as model	0
18.	Evaporation - 54" per year - model shows more	+
19.	Precipitation 14" model shows none	+
20.	Winter is moderate - same as model	0
21.	Consolidation possibilities - yes - exceeds model	+
22.	Beet continuity - yes - agrees with model	0
23.	Financial Analysis - with no changes - model indicates L	+
24.	Financial Analysis - 0.5 BOD or zero 77 land available M	-
25.	Financial Analysis - zero discharge 77 M	-
26.	Steffen House - model is Straight House	+
		10 +
		3 -

From this analysis, the 10 plus factors need to be weighed against the 3 minus factors. Those zero factors, that is like the model, do not need to be adjusted. The most serious negative factor is the "maybe" impact of the model financial analysis for zero discharge which indicates a "maybe" closure; but this is offset by several positive factors:

a. Capacity is larger than model.
b. 125-day campaign compared to model's 115 days.
c. The 467 acres owned compared to 210 needed acres -- a definite and strong plus.
d. Its pending co-op ownership would indicate a strong plus as the grower-owners would want this plant to continue.
e. Bay and Gerring and Mitchell are the nearby plants and if a consolidation were to occur, Scottsbluff would be one of the surviving plants because of its size, land and longer campaign.
f. Steffen House extends campaign by a few days.

On the basis of this analysis, Scottsbluff is a strong candidate to withstand the economic impact of zero discharge or a low probability of closure. The same sequence of analysis was used for determining the impact on each of the 52 plants of the industry.

At the end of the 1972-73 campaign, five plants have hookups with municipal systems; 11 plants have waste water treatment facilities and are considered zero discharge. One plant has closed. Therefore, 36 remaining plants were considered in the closure analysis.

BPT Closures

In evaluating closure potential, plants were looked at under four BPT conditions. The first condition considered was the baseline. This case assumes no changes or additions to the water effluent standards. These projections purport to show normal attrition.

The second condition considered was the final limitations' guideline of 0.5 pounds BOD_5 per daily ton of beets processed for all plants in 1977.

The third condition was 0.5 pounds BOD_5 per ton processed or zero discharge for plants with land available in 1977. The land available alternative assumes that if a plant has land available for complete water treatment under the EPA land formula, owned and contiguous to the beet factory itself, it must achieve zero discharge to the surface waters in 1977.' If such land is not available according to the EPA formulae (see Chapter V) then the plant shall achieve or maintain a discharge of 0.5 lbs BOD per ton of beets sliced by 1977 and zero discharge by 1983.

The fourth condition is zero discharge by 1977 for all plants. These numbers are not additive to those in the above condition but deal only with the zero requirement for 1977.

In evaluating the closure impact of 1983 standards, no separate analysis has been performed. The limitation of 0.3 lbs BOD_5 per daily ton of beets processed for plants with 2,300 tons or less of daily capacity and/or with a soil filtration rate of 1/16 inch or less produces the same financial results as the 0.5 lbs BOD_5 standard, since there are no significant costs associated with achieving the 0.3 limitation on top of the 0.5 standard. Also, with the information currently available, the zero discharge standard for all other plants in 1983 would produce the same closure estimates as zero discharge in 1977, except that the additional time might allow new technology to be employed or cooperatives might take over additional plants. These developments could reduce the number of estimated closures.

Table VI-7 summarizes the closure probabilities for 1977, reporting plants by region as "high, maybe or low." Table VI-8 shows the ranges of the estimated closures due to the various 1977 pollution control alternatives. The numbers are not additive, but rather show the number of probable closures from the estimates in Table VI-7. The minimum number consists only of those plants with high probability of closure, while the maximum number is composed of the "high" and "maybe" categories of probable closures.

From Tables VI-7 and VI-8, the numbers of probable closures under baseline conditions are two to six plants (two "high" plus four "maybe" probabilities). Under the alternative of 0.5 lbs BOD_5, the range is three to five. Three Region I plants are high probabilities; two other Region I plants are medium probabilities and are added to obtain the maximum number.

Under the third and fourth alternatives, the incidence of probable closures rises. The 0.5 lbs BOD_5 or land available concept produces a range of four to ten probable closures. The four high probability cases are three plants in Region I and one in Region III, none of which were on the "high" or "maybe" baseline closure list. Six others must be added as possibilities to obtain the maximum number of thirteen:

- two plants from Region I

- one Region III "maybe" case which was not a baseline probability

Table VI-7. Closure probability estimates under various pollution control alternatives for 1977

Alternative Probability	Baseline Condition			0.5 lbs. BOD 1977			0.5 lbs. BOD 1977 or Land Available Concept			Zero Discharge for all plants 1977		
	High	Maybe	Low	High	Maybe	Low	High	Maybe	Low	High	Maybe	Low
Region I	0	0	5	3	2	0	3	2	0	5	0	0
Region II	0	0	4	0	0	4	0	0	4	0	2	1
Region III	1	3	10	1	3	10	2	4	8	5	3	6
Region IV	1	1	9	1	1	9	2	1	8	2	1	8
Region V	0	0	2	0	0	2	0	1	1	0	1	1
Total	2	4	30	5	6	25	7	8	21	12	8	16

Table VI-8. Range of closure probability estimates due to various pollution control alternatives for 1977.

Alternative	Minimum	Maximum
Base (no controls)	2	4
.5 # BOD '77	3	5
.5 # Bod '77 or Land Available Concept	4	10
Zero discharge for all plants '77	7	17

Note: The numbers are not additive.

- one Region IV plant which is a high probability under the third alternative but was excluded from the minimum of four because it was also a baseline "maybe" case.

- two plants - one each from Regions IV and V - which are "maybe" cases under the third alternative but were not baseline probabilities.

The fourth alternative (zero discharge for all plants in 1977) produced a range of seven to seventeen probable closures. The seven minimum includes all five plants in Region I and two in Region III, none of which were on the baseline closure list. The maximum of seventeen plants includes the above seven plus the following:

- three plants in Region II which are medium probabilities under the zero discharge alternative and were not on the baseline list.

- two plants in Region III which are medium probabilities baseline cases.

- two plants in Region III which are medium probabilities under the zero discharge alternative.

- two plants in Region IV, one of which is a baseline medium probability for closure and one of which is a medium probability under zero discharge and is not on the baseline list.

- one plant in Region V which is a medium probability under zero discharge and is not on the baseline list.

Table VI-9 summarizes the estimated closures in terms of plant numbers and estimated production tonnage. The closure of 3 to 6 plants under the first condition represents 3 to 7 percent of production. Under the second condition, the closing of 4 to 10 plants represents 5 to 14 percent of production. Under the third condition, 7 to 17 plants might close, representing 9 to 26 percent of production. The tonnage under either case would be nearly offset by the three new beet sugar plants being constructed in Minnesota and North Dakota. These three new plants, programmed to be zero discharge operations, will add almost 11 percent to the current capacity.

It is likely that consolidation of plants in some of the areas of shutdown will occur. Thus the production of the surviving plants may increase to offset partially the production of closed plants. This seems most likely in Region III, the Western Plains. However, consolidation will not offset the anticipated closings and losses expected in Michigan, Region I. A new, larger type plant with complete water treatment facilities may be expected to replace the plants in this impacted area but no evidence of this has been observed.

Table VI-9. Net estimated production effects of closures due to various pollution control alternatives for 1977.

		Baseline Conditions No Control				.5 # BOD '77				.5 # BOD '77 or Land Available Concept				Zero Discharge for All Plants '77			
	Range	No. of Plants	Lost Beets	Total Beets	Percent	No. of Plants	Lost Beets	Total Beets	Percent	No. of Plants	Lost Beets	Total Beets	Percent	No. of Plants	Lost Beets	Total Beets	Percent
Region I	Min.	-	-	-	-	3	780	2,701	28.8	3	780	2,701	28.8	5	1,685	2,701	62.4
	Max.	-	-	-	-	5	1,685	2,701	62.4	5	1,685	2,701	62.4	5	1,685	2,701	62.4
Region II	Min.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Max.	-	-	-	-	-	-	-	-	-	-	-	-	3	1,812	2,617	69.2
Region III	Min.	1	219	5,257	4.2	-	-	-	-	1	275	5,257	5.2	2	607	5,257	11.5
	Max.	4	1,056	5,257	20.1	-	-	-	5.4	2	542	5,257	10.3	7	1,996	5,257	37.9
Region IV	Min.	1	120	9,075	1.3	-	-	-	-	-	-	-	-	-	-	-	-
	Max.	2	395	9,075	4.4	-	-	-	-	2	644	9,075	7.1	1	369	9,075	4.0
Region V	Min.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Max.	-	-	-	-	-	-	-	-	1	682	5,719	11.9	1	682	5,719	11.9
Total	Min.	2	339	25,369	1.3	3	780	25,369	3.1	4	1,330	25,369	5.2	7	2,292	25,369	9.0
	Max.	6	1,451	25,369	5.7	5	1,685	25,369	6.6	10	3,553	25,369	14.0	17	6,544	25,369	25.8

BAT Closures

As noted earlier, 1983 standards limit discharge to .3 lbs. BOD_5 per ton of beets processed for plants with 2,300 tons or less of daily capacity and/or a soil filtration rate of 1/16-inch or less and zero discharge for all other plants. In the BAT closure analysis, the net present values used for the .3 lbs. BOD_5 standard are those developed for the .5 lbs. standard for 1977, since there are no significant incremental costs in achieving the .3 limitation on top of .5. Also, the net present values for zero discharge in 1977 have been used for 1983, since the same financial data has been applied to both years.

The minimum number of estimated closures attributable to BAT standards is one -- a Region III plant which was not on the baseline or the .5 lbs. BOD_5 condition list for 1977. This plant must go to zero discharge in 1983, because it is greater than 2,300 tons capacity and has a filtration rate greater than 1/16-inch.

The maximum number of estimated closures is two. In addition to the Region III plant mentioned above, there is one other Region III plant which must go to zero discharge in 1983 and is a medium probability for closure. It was not in trouble at the .5 lbs. BOD_5 level; thus its closure in 1983 would have to be attributed to pollution controls.

There are five plants in Region I which do not have to go to zero discharge in 1983 because of size and/or filtration rates. These plants would only have to achieve the .3 lbs. BOD_5 limitation by 1983; however, all of the Region I plants are high or medium probabilities at the .5 level of control. Thus, their potential closure would be attributable to BPT rather than to BAT standards.

BPT plus BAT closures

In summary, with the .5 lbs. BOD_5 standard in 1977 and the .3 lbs. or zero discharge standard in 1983, the range would be four to seven plants. This would be the three to five plants under the .5 lbs. BOD_5 standard plus the one to two plants under BAT.[1]

D. Employment Effects

Beet sugar plants do not employ a large labor force for the size of their output measured in dollars or tons. The average plant will employ 50 people on a full-time, year-around basis and approximately 200 full-time people on a seasonal basis during the campaign.

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[1] Estimates given in the promulgation document are lower than those presented in this report because three Region I plants which were probable closures applied for permits at the .5 lbs. BOD_5 level after the initial publication of this report but prior to the promulgations.

These seasonal employees are relatively unskilled and this employment is not their primary source of income. Many of these workers are farmers working during the off-farm season. On the other hand the full-time workers are semi-skilled and skilled and this work is their major source of income. Because of their skill, however, they are believed to be employable in other industries in beet plant areas.

It is estimated that the range of displaced employees would vary from a minimum of 200 full-time and 800 seasonal employees to a maximum of 850 full-time and 3,400 seasonal on a national basis. The primary impacted area is Michigan where the likelihood of other industrial employment is possible. The Western Plains is also an impacted area but it too should be able to absorb this work force.

It does not appear that the employment impact or effect of displaced or terminated employees in this industry would be a major problem.

E. Community Effects

The community effects of closures are likely to be more serious from the loss of growers than from the loss of employees. Each plant represents about 300 growers who would be affected by a shutdown and loss of beet outlet.

As pointed out for Region III, this impact may not be great if the closing of one plant means its capacity and processing are picked up by a nearby plant. However, if this does not occur, it simply means the loss of beets as a profitable crop and the need to switch to lesser value crops, which will mean fewer dollars circulating in the respective communities.

The attraction of sugar beets to growers is not hard to explain. Table VI-10 shows the average net return to management for the U. S. is $55.00 per acre of beets grown. Compared to income from other crops, sugar beets rank high. However in Region I, the beet returns are low relative to other crops.

In addition to returns per acre, there are benefits to soil where beets are used in a crop rotation. Because the sugar beet is deep rooted, it is a good crop to alternate with shallow-rooted crops needing heavy fertilization. The beets' extensive root system draws

Table VI-10. Returns costs and profits per acre of sugar beets planted by regions, 1968

	Region I	Region II	Region III	Region IV	Region V	U.S.
Production						
Beet acres per farm	40.2	125.5	84.5	71.0	191.4	81.0
Yield per planted acres (tons)	16.4	13.0	16.8	17.6	21.5	17.2
Returns						
Sale of beets	$216.0	$166.0	$237.0	$277.0	$315.0	$255.0
Sugar Act	43.0	29.0	38.0	45.0	48.0	42.0
Hauling allowed	-	2.0	1.0	1.0	9.0	3.0
Sale & use of beet tops	3.0	1.0	14.0	15.0	4.0	9.0
Total Returns	262.0	198.0	289.0	338.0	376.0	309.0
Costs						
Direct costs	139.0	96.0	148.0	219.0	210.0	164.0
Indirect Costs	37.0	22.0	35.0	42.0	45.0	36.0
Total direct & indir.	176.0	118.0	183.0	261.0	255.0	200.0
Total Rent & Interest	57.0	27.0	54.0	14.0	58.0	53.0
Costs exclusive of management	234.0	145.0	237.0	275.0		253.0
Management income	28.0	53.0	52.0	63.0	63.0	55.0

Source: USDA, ASCS Sugar Division.

moisture and plant nutrients from as deep as 4 to 5 feet, in well drained soil, thereby benefiting from much of the fertilizer left by the shallow-rooted crops.[1]

Another community impact would be the tax base loss of a beet sugar plant with book value assets of 3 to 10 million dollars.

Again the impact is spread to isolated communities involving 4 to 17 total plants. The greatest impact would be in Michigan where other industrial opportunities may be present.

One new element, however, with community overtones is just now becoming present. This is the fact that some impacted and possibly closing plants are owned cooperatively by newly formed groups. Such groups have pledged somewhat over $100 per beet acre by cash or loan to initially finance the take over of the beet companies. The loss of a plant essentially financed by a mortgage on the farm would have serious consequences on these agricultural communities in Colorado, Nebraska, Wyoming, Minnesota and North Dakota.

F. Balance of Payments Effects

With the implementation of discharge controls, it has been shown some eight to 25 percent of the beet sugar capacity would probably close. Were this to happen the allocation of production and making of sugar would be shifted to

(a) Other beet sugar plants
(b) Cane sugar production, or
(c) Foreign raw sugar imports.

If a or b did not happen due to any number of factors, such as weather or lack of availability of other production facilities, then the increase of foreign imports of raw sugar would adversely effect the balance of payments. This would be of particular concern at present since every effort is being made by government to maintain the trend toward improvement in balance of payments. However, with the construction of three new beet sugar plants, the potential closures should not materially increase raw sugar imports.

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[1] "The Sugar Beet Industry in California," Circular 562, Agricultural Publication, U of Calif., Berkeley, Calif., 94720

VII. LIMITS TO ANALYSIS

A. General Accuracy

Data gathered were of a secondary nature, drawn from previously published reports, from private sources, contracted government studies and regularly reported government services. Personal interviews of key personnel of sugar beet companies and trade associations, together with field trips into most sugar beet areas, were conducted.

Throughout the study an effort was made to evaluate data and other information used and to update these material, wherever possible. Data were reworked so as to make its presentation more clear in light of the purpose of this report and to the use that is intended.

As a result of the data and the step-by-step methodology by which the conclusions are drawn, this analysis represents a systematic evaluation of the impact of effluent limitation guidelines on the beet sugar industry. However, it must be recognized that the data are subject to error, and the estimates represent the best possible informed judgments, given the limitations of time and budget.

B. Possible Range of Error

The instructions of the contract required that the contractor use the cost data provided by EPA under Supplement A Cost Analysis and to comment on these costs and technology. The following items indicate some of the range of error that is possible based on the use of the data supplied by EPA and the basic financial data.

Different data series and different sections of the analysis will have different possible ranges of error. Estimated error ranges as an order of magnitude are as follows:

	Error Range
1. For number, location, capacity, age and processes of plants	0.2%
2. Price information on products, materials and equipment	±5.0%
3. Sunk investment	±20.0%
4. Plant operating costs	±10.0%

	Error Range
5. Land Values	$500 - $4,000 acre
6. Incremental pollution control costs	±20.0%
7. Plant Closures	±15.0%

From EPA-provided formulae, the net sizes of lime, flume and condenser ponds were calculated. These are net acreages. It seems likely that a margin or buffer zone acreage should be added to the net area in the order of 20 percent. This would account for the following conditions:

(a) Because of maintenance requirements, ponds cannot be built in one clear-cut size and place. Barriers and baffels are required to restrict or direct flow. Borders need to be kept at the edges for maintenance equipment to operate and larger ponds need to be sectionalized so that ponds may be rotated in use for clearing and maintenance.

(b) All land at a plant site is not equally useful for ponding due to topographical differences. Net pond sizes will not always fit the gross acreages.

With the control of flume water through ponds, there is a parallel problem of and cost for solid waste disposal.

EPA's "Supplement A Cost Information" provides for an annual flat fee for pond dredging of $15,000 per plant. For ponds 20 to 40 acres, this dredging cost is probably adequate but probably does not reflect the final disposal (hauling) of the solid material. The separating, loading, hauling, dumping and spreading of solids on the land or into a land fill represent a significant effort.1/ Dredging larger ponds of 200 and more acres is believed to represent a cost well beyond the $15,000 annual estimate. Some beet plants have projected future costs in excess of $100,000 per year to remove solid wastes, plus the cost of a landfill site for disposal of the solids. No attempt is made here to quantify this factor or to avaluate more precisely this economic impact.

While not directly a part of water pollution control, odor problems in beet sugar plants are directly associated with waste water control. As waste waters were discharged with little or no treatment, odor problems were not serious.

1/ "Separation, Dewatering and Disposal of Sugar Beet Transport Water Solids," by N. Fordyce and A. M. Cooley, Phase I, Office of Research and Monitoring, EPA, Washington, D. C., 20460.

The advent of water containment for treatment and control creates an odor source. Waste water from beet plants, particularly the flume or transport water when impounded in deep ponds or lagoons under aerobic conditions, promote the growth of sulfur reducing organisms and thus the generation of hydrogen sulfide and other gases. These obnoxious gases can be partially controlled or eliminated by maintaining aerobic conditions in shallow lagoons 1.5 to 2 feet deep or by the expenditure of energy for blowing air through the pond with aerators.

Costs provided by EPA do not include aeration equipment, which may become necessary if deep ponds are used rather than shallow evaporation ponds.

C. New Technology

Two new technologies, not evaluated, which have potential impacts on waste water disposal are in the early stages of consideration or use by the industry. One is the condensation of sugar vapor by compression rather than by cooling in a condenser. This technology, not fully developed for application to beet sugar, is of interest, because it eliminates the large volumes of water for condenser cooling and the further entrainment of sugar in the cooling water.

The principle involves the use of a compressor to convert the sugar vapor into liquid. Energy is required to accomplish this but a by-product of the process is that the heat generated in the compressing phase can be used as heat energy in the total beet sugar extraction process.

A second technical change in the processing of beet sugar is being used by two plants now and may find wider use in the future. This involves extracting the sugar from the beet and storing the raw sugar juice for refining at a later time. The key appeal for this pressing is a potential full or higher refining capacity by using the days beyond the standard slicing and extracting campaign.

A somewhat analogous processing is found in the cane sugar industry. The critical part in beet sugar processing is the ability to store "raw juice" without loss of quality. Storage tank designs and liquid surface coverings have apparently provided solutions for this quality problem.

The application of the latter processing change seems to indicate a further reduction in gross water use, thus reducing the total effluent discharge and possible improvements in plant economics. However, the economics remain questionable in the minds of some industry management personnel.

D. Critical Assumptions

A key assumption concerns the action of the Department of Agriculture in response to maintaining the health of the beet sugar industry. The Secretary of Agriculture can act on certain conditions which include maintaining orderly marketing and supply processes. Further, under the broad terms of the Sugar Act there are provisions to assure an equitable division of returns from sugar between beet and cane growers, farm workers and processors. However, it is unknown as to whether or how the Secretary would act in response to added costs to the processors arising from pollution control.

It has further been assumed that the growers would not be willing to take a lower beet price for their beets to offset these additional costs. In view of the buyer-seller conflict now present in beet purchase contract negotiations, this seems to be a reasonable assumption. However, grower response in face of pending and real plant closure possibilities may change and they may accept lower beet prices, in terms of real price adjustments or indirectly through plant ownership.

It was also assumed that none of the 36 plants not now at zero discharge or on municipal hookups would make municipal hookups. This assumption was discussed and verified with industry personnel, but when firms actually face the need for outlays in pollution control facilities and/or communities become aware of potential plant closures, municipal hookups may become viable alternatives.

It was assumed that inflationary effects on costs and returns will be proportional. However, the index of sewer construction is rising at a more rapid rate than the GNP deflator or the wholesale price index. If this continues (and the widespread imposition of pollution standards would suggest an ever faster rise) investment in pollution control by 1977 or 1983 may have even larger relative impacts.

An additional critical assumption is that plants meeting the .5 pounds of BOD_5 per ton of beets processed can move to a .3 pounds level without additional costs. Although this has been theoretically confirmed, it must be recognized that some plants may incur incremental costs in achieving the .3 level by 1983. Empirical data are needed to test this critical assumption.

E. Remaining Questions

Many questions remain regarding seepage, cost of land, total costs of pollution control and incremental investment pollution abatement facilities in addition to that already in place. Additionally, the evaluation of the above listed assumptions should be considered. Another important issue is how will the co-ops fare during these next few formative years of their existence. They not only have to cope with starting to manage large businesses with the normal attendant business problems, but also with the added concerns of financing pollution control equipment. The ability of co-op management to handle these problems is particularly important with regard to the 1977 alternative of zero discharge.